Master's thesis

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Perception of Risk in the Environment of Integrated Operations

A qualitative study of four expert groups' understanding of risk in the petroleum sector at the Norwegian Continental Shelf

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Preface

This thesis constitutes the final element of my master's degree in Risk Psychology, Environment and Safety (RIPENSA) at the Norwegian University of Science and Technology (NTNU), Department of Psychology. The thesis is written as part of a project called *Interdisciplinary Risk Assessment of Integrated Operations addressing Human and Organisational Factors* (RIO), administered by department of Safety Research, SINTEF Technology and Society. I was lucky enough to get in touch with one of the projects personnel, who showed interest in the contribution of a candidate for a master's degree. I have long been interested in how employees understand risk in relation to their line of work. Therefore, I was pleasantly surprised when risk perception concerning integrated operations in the petroleum sectors was offered as a research topic by the RIO-project. Working on this thesis has been an interesting, fun and challenging experience. It has been a great motivator knowing that my thesis will be of practical value and this has meant a lot to me.

First, I would like to thank my supervisor Britt-Marie Drottz-Sjöberg, for her inspiring guidance and advice. Next, I would like to express gratitude to Eirik Albrechtsen, the project manager of RIO, and Tor Olav Grøtan and Fred Størseth, two of the project personnel, as it has been great collaborating with you. The latter, I would also like to thank for introducing me to the RIO-project.

Last, but not least, to my boyfriend Magne Torsetnes and my sister Tonje Jenssen Espeland, I am very grateful for your wonderful support, help and good advice.

Trondheim, May 27th 2010

Therese Jenssen Espeland

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Abbreviations

- DSHA: Defined situations of hazards and accidents
- HSE: Health, safety and environment
- ICT: Information and communication technology
- IEC: International Electrotechnical Commission
- IO: Integrated operations
- IOS: International Organisation for Standardisation
- IPCS: International Programme on Chemical Safety
- MTO: Man, technology and organisation
- NCS: Norwegian continental shelf
- NENT: The National Committee for Research Ethics in Science and Technology
- NPD: The Norwegian Petroleum Directorate
- OLF: The Norwegian Oil Industry Association
- PSA: The Petroleum Safety Authorities Norway
- RAC: Risk Analysis Consultant
- R&D: Research and Development
- UNISDR: United Nations International Strategy for Disaster Reduction

Abstract

A general interest in risk perception and the current implementation project of integrated operations (IO) at the Norwegian Continental Shelf (NCS) laid the foundations for this thesis. Preceding effort from research teams and pilot projects has explored the effects and changes of IO to make sure the implementation of generation one and generation two will be safe. Still, the use of IO is expected to influence and possibly alter the risk picture and risk assessments of petroleum production. The RIO-project was initiated to develop new knowledge and frameworks for reasoning, as a basis and platform for risk assessment in relation to petroleum production in the environment of IO. On a request from the RIO-project this thesis explores how actors from different expert groups, in relation to petroleum production, perceive risk and risk management of IO. The findings are intended to generate ideas and information that can be utilised for suggestions on how employees in the petroleum industry could avoid or manage problems due to risk of IO. To gain insight on the subject matter a qualitative, semi-structured interview was conducted. The study consists of 13 respondents that were divided into four expert groups on the basis of their current place of work: industry members, researchers, supervisors and risk analysis consultants. The research findings were categorised and analysed according to some methods from Grounded Theory. The findings can be used to map out how these 13 actors in the petroleum sector perceive risk and risk management in relation to IO. It is further concluded that their risk perception differs and seems to be independent of the distribution across expert groups. However, as the study comprises relatively few respondents the results are insufficient to infer anything about the common perception of risk in the sector or in the expert groups. However, the results are significant and important in that they shed light on current beliefs about risk, especially in relation to the transition between generation 1 and generation 2.

Contents

1. Introduction

1.1 Field of Interest

The need to understand and the desire to manage risk have been the centre of attention in numerous debates since the end of the Second World War (Breakwell, 2007). Risk studies derived from the practical needs of industrialised societies to regulate technology and to protect the public and employees from natural and technological hazards (Golding, 1992). In the Norwegian petroleum sector major changes are currently taking place due to the recent, ongoing process of implementing and utilising integrated operations (IO) (OLF, 2007). The advantages of IO are believed to be immense. For instance, it will create new ways of organising work, managing work processes and increased automation, such as closer collaboration between offshore and onshore sites and collaboration across company and geographical borders (OLF, 2006b). However, concerns about IO altering the risk picture and creating new risk management challenges also exist (Grøtan, Størseth, and Albrechtsen, 2009). These worries might be legitimate as on 22nd April 2010 the BBC announced that the oilrig Deepwater Horizon sunk in the Gulf of Mexico two days after it caught fire due to an explosion (BBC, 22.04.2010). Even though the reason has no official connection to IO, DailyWireless explain that Deepwater Horizon was upgraded in 2002 and used e-drilling, which constantly transfer data from rig operations to a monitoring center in Houston, when the accident happened (DailyWireless.Org, 01.05.2010).

On the basis of IO concerns regarding the current development at the Norwegian Continental Shelf, the following research question was outlined:

> *How do actors from different expert groups perceive risk and risk management in relation to petroleum production in an integrated operations environment?*

1.2 The Collaborating partners: SINTEF and the RIO-project

As the largest independent research organisation in Scandinavia SINTEF was established in 1950 by the Norwegian Institute of Technology (NTH), which today is incorporated in the Norwegian University of Science and Technology (NTNU), to be a link between academia and industry (SINTEF, 2007). Their goal is to create new knowledge and solutions on the basis of research and development within a broad spectre of disciplines, such as technology, natural sciences, medicine and social sciences (SINTEF, 2009). SINTEF's Safety department is located in Trondheim, with a primary research objective of providing a better in-depth understanding of how to assess, monitor and control safety and reliability. It is an interdisciplinary department that strives to analyse and develop new knowledge about the interfaces of humans, technology, organisation and safety. Additionally, the department create models, methods and standards in order to manage safety and reliability issues efficiently and proactively. The departments' most important clients are the petroleum industry; both offshore and onshore, transportation and governmental administration (SINTEF, Teknologi og samfunn, u. d).

Increased activity and incorporation of IO in the petroleum industry at the NCS led to the initiation of the RIO-project. The full project title is: *Interdisciplinary Risk Assessment of Integrated Operations addressing Human and Organisational Factors (RIO)*. The project is run from the Department of Safety Research at SINTEF, Technology and Society, and funded by the Norwegian Petroleum Safety Authority, the IO-Centre at NTNU, and the PETROMARKS program of the Norwegian Research Council. The current technical risk analyses are believed insufficient in order to capture the new risks of IO, especially with regard to the impact of human and organisational factors. Thus, to gain the benefits of IO established risk approaches need to be supplemented by other approaches that address current human and organisational issues. The overall project goal of RIO is, therefore, to develop new knowledge (theories, models) and frameworks for reasoning that can be used as a basis for risk assessment in relation to petroleum production in an integrated operations environment. Furthermore, there is a need for a general framework that enables the creation and sharing of knowledge about risk among different petroleum actors to provide common understanding. Thus, the results of the RIO-project are expected to provide guidance to relevant practitioners in the petroleum industry (SINTEF, 2008).

1.3 Structure

Section 2 examines literature from relevant theoretical perspectives to shed light on the research question from various angles. Section 3 outlines the methodological approach of the thesis and thoroughly describes the research process. Choices that were made are mapped out and explained from the early planning phase to data collection and analysis until the end of the study. Section 4 presents the results of the interview study through quotes and summaries of the respondents' statements. Section 5 discusses the research findings in light of relevant theory, before implications for further research and an overall conclusion, are stated.

1.4 Definition of concepts

In order to fully comprehend fundamental aspects of the thesis a definition of the concepts involved are necessary[1].

Defined situations of hazards and accidents is "used by petroleum companies operating on the Norwegian Continental Shelf to specify a selection of hazardous and accidental events, based on which emergency preparedness can be established" (Tveiten, Albrechtsen, and Skjerve, 2009, p. 5).

Expert judgment is the "opinion of an authoritative person on a particular subject" (IPCS, 2004, p. 12).

Hazard[2] is seen as "the situation that in particular circumstances could lead to harm" (Warner, 1992, p. 3).

Integrated operations is "the use of information technology to change work processes in order to obtain improved decision-making, to control equipment and processes from a distance, and to relocate functions and personnel onshore"[3] (Norwegian Ministry of Petroleum and Energy, 2003-2004, p. 34).

Major accident "an unexpected occurrence, failure or loss beyond normal or specified levels with the potential for harming human life, property or the environment" (EIONET, 2010, *major accident*).

Risk is "the combination of the probability of an event and its consequences" (ISO/IEC, 2007, Guide 73, p. 4).

[1] It should be noted that different definitions exist for some of the concepts utilised. However, the definitions outlined denote the concepts' meaning in this thesis.
[2] The concepts of hazard and vulnerability are treated as synonyms in this thesis because of inconsistent use by respondents in the interview study.
[3] Translation by the author.

Risk communication is the "exchange or sharing of information about risk between the decision-maker and other stakeholders" (ISO/IEC, 2007, Guide 73, p. 5).

Risk perception is the "the outcome of the processing, assimilation and evaluation of personal experiences, or information about risk, by individuals or groups in society" (Renn 2008: 374).

Risk management is the "coordinated activities to direct and control an organization with regard to risk" (ISO/IEC, 2007, Guide 73, p. 5).

Threat is the "potential cause of an unwanted incident, which may result in harm to a system or organization" (ISO/IEC, 2007, Guide 73, p. 6).

Vulnerability[4] is the "weakness of an asset or control that can be exploited as a threat (ISO/IEC, 2007, Guide 73, p. 6).

[4] The concepts of hazard and vulnerability are treated as synonyms in this thesis because of inconsistent use by respondents in the interview study.

2. Theory

This section outlines selected theoretical perspectives that shed light on the research question.

2.1 Integrated Operations

This subsection will briefly denote the meaning and development of IOs.

2.1.1 What are integrated operations?

Recently a tremendous expansion in the use of information and communication technology (ICT), automation technology, sensor technology and smaller, isolated technologies has taken place in the petroleum sector at the Norwegian Continental Shelf (NCS). This development together with altering work practices and new operational concepts is usually denoted integrated operations (IO) (OLF, 2008). There exists no common or agreed upon definition of IO (Tveiten *et al*., 2009), but different petroleum companies tend to use definitions with corresponding objectives (OLF, 2008). The Norwegian Oil Industry Association (OLF) defines IO as "real time data onshore, from offshore fields, and new integrated work processes" (OLF, 2008, p. 5). Several company dependent terms like smart operations, eOperations, smart filed, field of the future, real time operations, smart wells, i-field, eDrift, e-drilling, digital oil field of the future/DOFF, and intelligent filed optimisation and remote management/INFORM also refer to IO (OLF, 2006b).

Three aspects constitute IO: utilisation of new ICT, altered work processes and relocation of operations. If any of these aspects occur separately, it is not IO. The petroleum industry is familiar with the use of ICT, as it has been used for a long time in planning and carrying out well drilling to optimise production. However, using ICT as a strategic tool to increase work efficiency and decision-processes, as well as delegate tasks between land and sea and between operators[5] and suppliers is the innovation of IO. As a result, the industry will incorporate new work processes and the latest ICT, in order to enhance automation (OLF, 2006b). According to The Norwegian Ministry of Petroleum and Energy (2003-2004) different petroleum companies tend to include different elements in the concept of IO. This has given rise to a

[5] Operator/ Operator companies are companies entitled to look for oil and gas, and start production if they find a field (PSA, 2010i, Operatørselskap/ Operatør).

belief that IO will mean different things to different people, both now and in the future. In accordance, OLF published a report stating that the meaning of IO is expected to change over time and this development is comprised of three stages (See figure 1) (OLF, 2005).

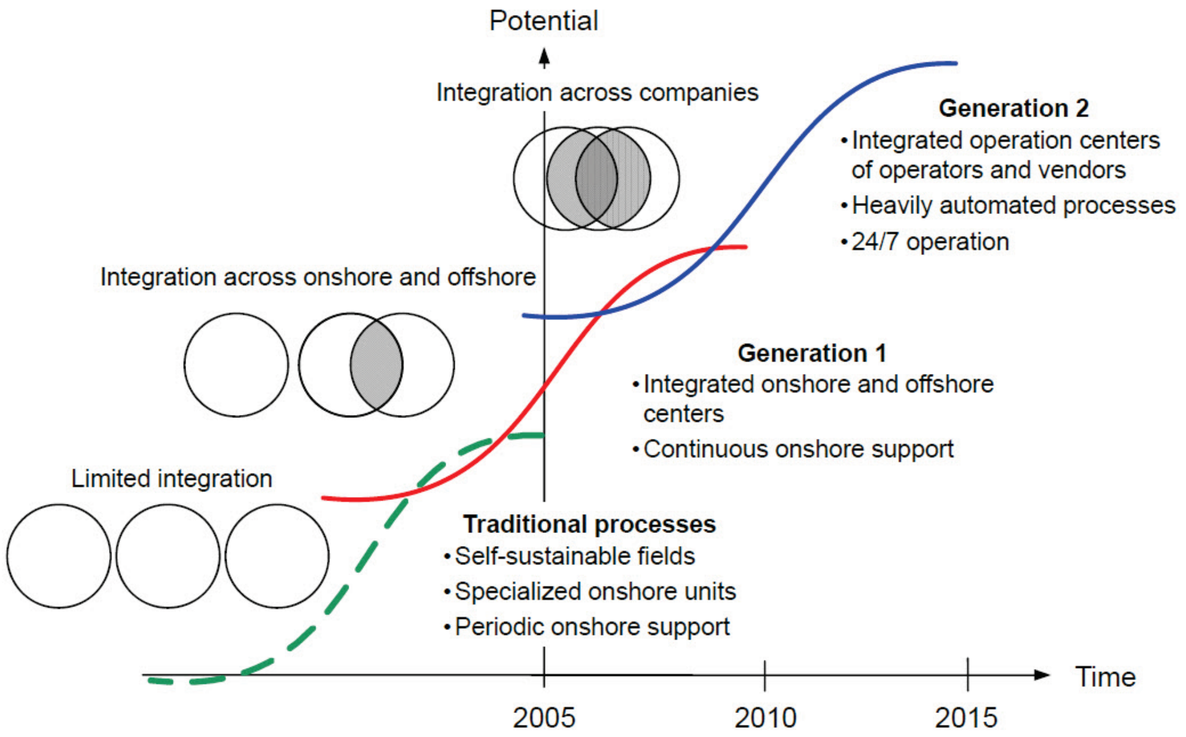

Figure 1. The Norwegian Oil Industry Association's (OLF) suggestions of IO characteristics over time. Source: OLF, 2005, p. 9. Used with permission by OLF.

According to OLF (2005) the first stage, *traditional processes*, is characterised by some of the following aspects:

- Decision-making about operative elements is made offshore with limited support form onshore experts.
- The organisational structure is traditional, indicating that onshore and offshore personnel are working in different units with dissimilar goals.
- Plans and problem solving would be fragmented while one sought to develop disciplinary procedures.
- The specialised IT-systems would be difficult and time consuming to use in order to gather needed data.

OLF (2005) further explain that the second stage, *generation 1*, is expected to cause relatively simple but profound changes to the traditional work processes, including:

- Onshore and offshore personnel have become more closely integrated.
- Decision-making, problem solving, data comparison, operation monitoring and comparison, as well as safety challenges, need to be solved in collaboration that is made possible by extensive use of real time data.
- Onshore expert centres are expected to provide 24 hours support and be capable of running fields.

Finally, OLF (2005) outline how the third stage, *generation 2,* signifies that:

- Oil and gas fields on the NCS will be run by personnel located in operation centres onshore that belong to both operators and vendors;
- The operation centres' geographical location may vary within national as well as international borders.
- Interaction with offshore fields is expected to continue relentlessly and is associated with automatic processes and digital services[6].
- Vendors are responsible for everyday work practices as well as decision-making, such as monitoring, analysing and optimising, tasks that were previously carried out by the operators. However, the operators will receive digital information in real time when irregularities are registered and make the necessary decisions in order to handle these situations and have the overall operative responsibility of fields at the NCS.

2.1.2 The implementation process

A project named *Integrated Work Processes (IWP)* was initiated by OLF in the autumn of 2004, to make use of IO in order to improve the Norwegian sector's economic growth. The implementation of IWP was allegedly successful. It was supported by several initiatives "launched by operators, partners, OLF, NPD as well as universities and R&D institutions" (OLF, 2005, p. 3). Although the technological development of creating IO solutions had already been initiated, OLF portrays 2005 as the starting point for IO. According to the timeframe of IO (see figure 1), generation 2 is expected to be fully implemented by 2015 (OLF, 2005). However, as the implementation of IO was initiated at a different pace throughout various companies it quickly became evident that the field development, uptake of new ICT and work processes was moving too slowly. Consequently, a new report in 2008

[6] Digital services are operational concepts that are based on delivery of large portions of the services required to operate a field "over the net" (OLF, 2005, p.17).

stated that the chance of reaching the full potential of IO in the expected time frame was small. The large number of isolated and varied solutions across an even greater amount of oil and gas fields was described as a significant concern in the current situation. The development of a general process for implementing new integrated solutions had turned out to be difficult due to the complexity of the new applications and their many interfaces (OLF, 2008).

2.1.3 Pros and cons of IO

A major goal of IO is their ability to improve the potential for value creation on the NCS (OLF, 2005). It has been estimated that new technical and organisational solutions could increase oil recovery by 3-4%, accelerate production by 5-10% and lower operational costs by 20-30% (OLF, 2003). Increased profit is considered a possibility, as new ICT might create faster and better decision-making that can enhance production and extract a greater deal of natural recourses (OLF, 2006a). Additionally, IO are emphasised as creators of positive organisational changes with regard to work processes, infrastructure and the use of collaboration technology (Tveiten *et al.,* 2009). Equally, the Norwegian Ministry of Petroleum and Energy stated:

> *"The foundation of e-operations is computer technology, which enables information to be transferred across extensive distances with hardly any delay. Onshore personnel will therefore receive identical information at the same time, as offshore personnel. This increases the opportunity to change ways of working. Different technology and knowledge may join together and unite work tasks concerning ocean and shore, operators and suppliers"* (The Norwegian Ministry of Petroleum and Energy, 2003-2004, p. 34-35).

Moreover, OLF (2006a, 2006b, 2008) outlines how IO may result in improved health, safety and environment (HSE) performance as the risk is reduced within many operational sectors. For instance, the utilisation of remote operations will enable installations to reduce their amount of personnel. Consequently, less people will be exposed to hazards and risk. The risk management of HSE may also improve, since more and better information is obtainable through real time data. The response time when incidents occur may become shorter due to the onshore/offshore integration, and safety levels might improve due to the application of new ICT and work processes. Similarly, Ringstad and Andersen (2006) emphasise that IO might have beneficial effects on HSE. For example, successful implementation of IO might benefit areas like drilling, reservoir management/production, processing and maintenance. Risk management in general is likely to experience a positive development of IO, as it is possible to use tools for analysis in real time. Additionally, IO is expected to originate a better connection between disciplines and improved decision-making (OLF, 2006b).

Nevertheless, the implementation of IO has also brought about concerns with regard to new and altering risk aspects. Tveiten *et al.* (2009) predict that IO will create new challenges in relation to training and emergency exercises. Ringstad and Andersen (2006) outline the four key areas in which they expect HSE challenges to occur. *Workload* refers to the mental workload remaining offshore personnel might face as tasks and colleagues are relocated onshore. *Work place design* refers to the planning of permanent operation rooms in order to provide employees with ergonomics and support facilities, as well as the installation of communication tools in expected areas that are easy to find. *Accident risk* refers to how decision-makers may have less hands-on experience or the fact that a breakdown in onshore/offshore communication might occur. *Competence* refers to how training will be required at individual levels to master new work procedures, and across disciplines to join together multidisciplinary teams.

2.2 Risk

This subsection seeks to illustrate some of the complexity that surrounds risk and risk perception, as well as briefly draw attention to a couple of central theories on risk perception.

2.2.1 Examples of risk perspectives

According to Slovic (2000) the concept of risk is subjective and invented by humans in order to understand and handle the many hazards and uncertainties of life. He furthermore emphasises hazard as real, but claims no such thing about risk, which is established as neither real nor objective as all evaluations of risk are founded upon theoretical models. Renn (2008) refers to risk as a complex concept that has instigated many debates in various academic disciplines. Furthermore, he emphasises that perspectives and classifications on how to describe and understand risk in general originate from scientific theories. In addition, he claims it is possible to argue that all risk concepts have one element in common: the distinction between reality and possibility (Renn, 1992).

There have been several attempts to map out and categorise risk. One of them is the systematic classification of risk perspectives (see figure 2) developed by Renn (1992). He explains the different outlooks on risk according to academic disciplines and distinguishes between technical, economical, psychological, sociological and cultural science.

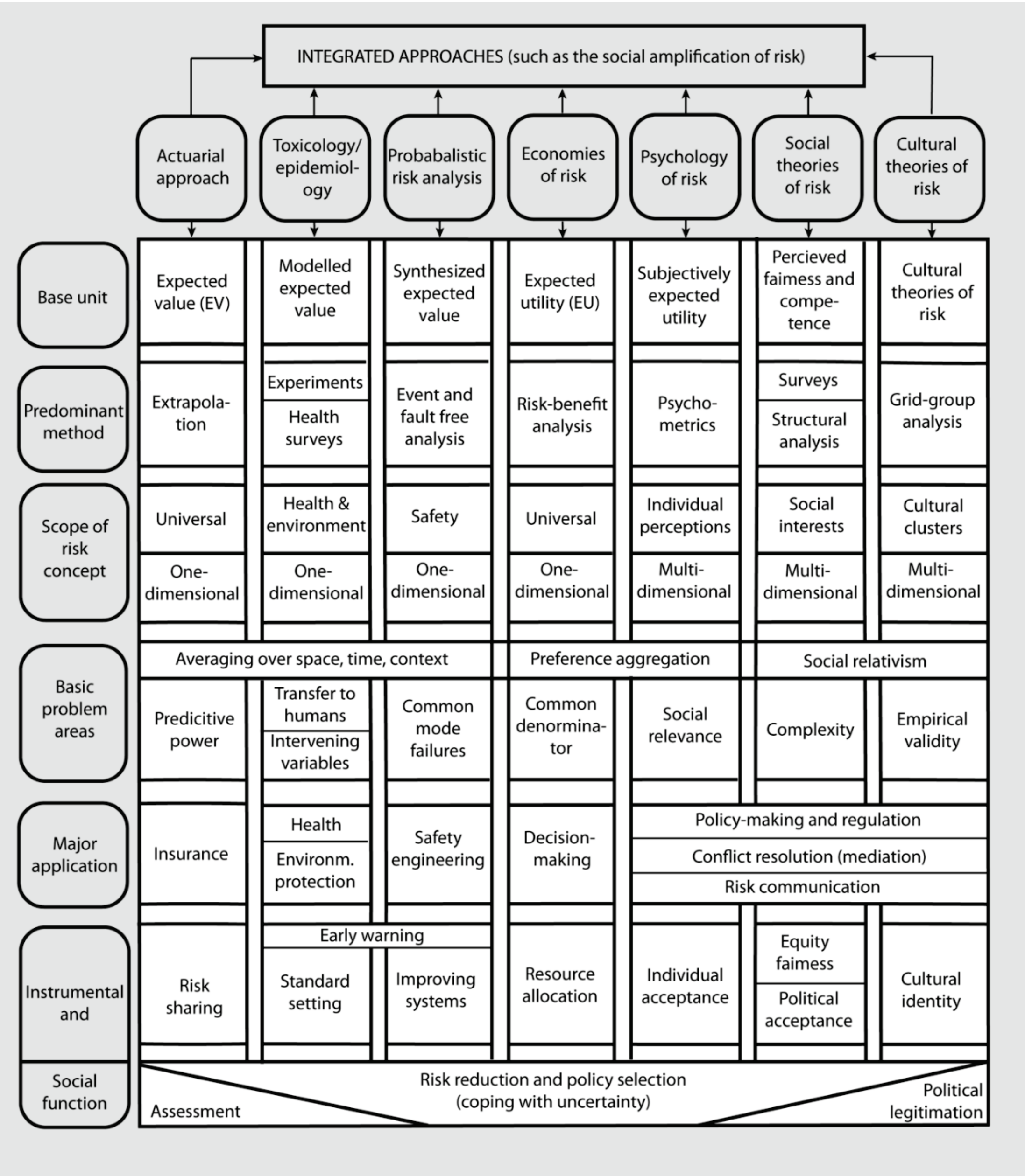

Figure 2. A systematic classification of risk perspectives Source: Renn, 1992, p. 57. Used with permission by the creator: Renn, O.

Technical disciplines like engineering science tend to denote risk as "a functional relationship between probability and adverse effects" (Renn 2008, p. 98) and it holds three main approaches: actuarial, toxicological and epidemiological[7]. The underpinning element of the actuarial approach is expected value (EV), whereas the toxicology and epidemiology approach explicitly explore model value, and the engineering approach holds the synthesised EV (Renn 1992). Aadnoy, Cooper, Miska, Mitchell, and Payne (2009) elaborate how the oil and gas industries are founded upon engineering principles in relation to well drilling. In accordance, Crossland, Bennett, Ellis, Gittus, Godfrey, Hambly, Kletz, and Lees (1992) explain how risk estimation areas by engineers tend to fall into one of the following three categories: a) Statistical risk estimations which identify a number of casualties; b) Established risk in which the link between causes and injury is difficult to trace, like cancer after radiation exposure; c) Estimated risk of likely events that have not yet occurred.

The economic perspective of risk is closely related to that of technical science, while psychological science gives the concept a more substantial and complex meaning (Krimsky and Golding, 1992). Through a psychological perspective, risk is influenced by subjective assessments, decision-making and contextual settings. The psychological research on risk seeks to move away from the somewhat narrow comprehension, which often exists, that risk concerns solely quantitative measures that are possible to assess and estimate (Renn, 2008). The field of risk psychology is dedicated to showing that the complexity of risk is dependent on the context in which the term is used, while seeking to explain how human perception, attitude, judgment and action influence risk related issues (Breakwell, 2007). Psychological analyses of risk are extensive and important processes that concern risk at individual, institutional and societal levels (Hastie and Dawes, 2001).

The sociological outlook on risk is diverse as it comprises not one, but several minor perspectives that are difficult to unite. These include organisational studies, accident studies, media coverage and communication, risk conflicts and reasons, justice and equity, population studies and epistemology of risk knowledge (Renn, 1992). Cultural theories of risk emphasise the human interaction and reject theories about isolated and rational actors. The social response to risk is related to cultural patterns and values. Hence, they both believe that risk

[7] Toxicological and epidemiological refer to assessments of health and environmental risks (Renn, 1992, p. 58).

attitude studies, based on group or societal levels, need to be done with respect to the cultural environment and the individuals belonging to it (Haukelid, 1999).

2.2.2 Risk perception

According to Slovic (1992a) the term *risk perception* originates in psychology and seeks to explain how people understand and evaluate risk and the concept as referring to individuals' subjective impressions of risk. He further believes that risk cannot be perceived in the sense of being taken up by the human senses, such as images of real phenomena like a hazard. Consequently, human risk perception needs to be understood through a mixture of science and judgment that comprises psychological, social, cultural and political factors (Slovic, 1992b). According to Renn (2008) risk perception is commonly known as a label that tends to be used by the social sciences in relation to human decision-making about events, situations or activities that could lead to negative consequences. He explains how an early belief claimed that risk perception was influenced by facts or elements understood as facts due to association with risk analysts, scientists or other experts. However, it was soon discovered that not only estimations of technical risk influenced risk perception but numerous other components had explanatory value (Sjöberg, 2000). For instance, people with various educational backgrounds, interests and/or tenure often perceive risk differently (Sjöberg, 1998). Human traits like personality, cognitive features, presumptions and experience (Renn, 2008), as well as characteristics such as self-efficacy, control and profession belonging are also mentioned. Additionally, group factors like nationality and culture and socio-demographical characteristics, like sex and race, are viewed as explanatory elements of risk perception (Breakwell, 2007).

The fact that people seem to link expectations, ideas, hopes, fears and other emotions to events with uncertain outcomes, have resulted in attempts to map out consistent patterns of how people understand and think about risk. However, the degree of perceived seriousness of a risk seems to be strongly related to actual exposure, rather than to the number of fatalities, which most risk assessments[8] are based upon (Renn, 2008). Perez-Floriano, Flores-Mora, and MacLean (2007) mention how trust can be an important and influencing factor of risk

[8] Risk assessment is the task of identifying and exploring, preferably in quantifying terms, the likelihood of the consequences related to a risk. Risk assessment comprises hazard identification and estimation, exposure, and vulnerability assessment and risk estimation (Renn, 2008, p. 373).

perception, especially in relation to complex technology. For instance, employees who are exposed to high risk and difficult technology are found to be more comfortable and perform their tasks in a more relaxed way if they trust that management will not expose them to unnecessary harm or unknown hazards. Because of the concept's complexity research from areas such as geography, sociology, political science, anthropology and psychology have contributed to the understanding of human risk perception through various theories and models (Slovic, 1992b). However, attempts to model risk perception have mainly been done in two very different ways. On the one hand is a mainly theoretical approach, for example cultural theory, and on the other you have the empirically based Psychometric paradigm (Sjöberg and Drottz-Sjöberg, 2009).

2.2.3 Theories of risk perception

Cultural theory seems to have originated from two different quarters. According to Rayner (1992), it arose from Michael Thompson's article "Aesthetics of risk: culture or context" published in 1980. In contrast Wildavsky (1993) claims that the 1982 paper "Risk and culture: An essay on the selection of technical and environmental dangers" by Mary Douglas and himself is the theory's starting point. Nevertheless, Cultural theory suggests that risk is defined, perceived and managed in the course of inherent, cultural and social factors. For instance, people decide what to fear in order to protect their way of life, such as hazards that threaten locally valued social and institutional arrangements (Rayner, 1992). Systematic variation in risk perception may seem inevitable as people come from different cultural backgrounds (Breakwell, 2007). Critics of cultural theory stress how the developed principles have limited practical meaning (Rayner, 1992). Even though the theory's ability to identify dominant cultural patterns that determine individual and social responses to risk is influential, social scientists discuss the patterns validity in terms of theoretical interpretation and empirical support (Renn, 2008).

The psychometric paradigm is a methodological approach that enables researchers to create explanatory models about human comprehension of risk, such as the psychometric model (Breakwell, 2007). The approach seeks to find an explanation regarding differences in risk perception between for instance lay people (the public) and experts (Golding, 1992). It was influenced by Chauncey Starr (1969) who wanted to create a method that made it possible to evaluate technical risks alongside the question of acceptability (Slovic, 1992b). By using psychometric scaling methods and analysis techniques the psychometrical paradigm aims to produce qualitative measures or cognitive maps that explain human risk perception and attitudes (Slovic, 1992b). Although utilisation of this approach has produced interesting results, inspiring further research, it has limitations with regard to its strong assumptions (Slovic, 1992a). The psychometric paradigm is supported by the psychometric model, which holds explanatory scales that allows participants to rate hazards according to factors such as novelty and dread (Fischhoff, Slovic, Lichtenstein, Read and Combs, 1978). The psychometric model's explanatory value was initially believed to be extremely good and account for 60-70% of variations in perceived risk. Consequently, the model was highly respected and was used as a basis for extensive research on risk communication (Sjöberg, 2000). Nonetheless, when new factors where added the explanatory value of the psychometric model and cultural theory have turned out to be significantly poorer than previously assumed (Sjöberg, 1998). The psychometric model has been found to explain 20% of the perceived variation in risk perception, while cultural theory merely explains 5-10% (Sjöberg, 2000). In spite of its shortcomings the psychometric model is still the most promising model of risk perception (Sjöberg and Drottz-Sjöberg, 2009).

2.3 Decision-making about risk

This subsection briefly outlines a few of the central historical aspects of decision-making theory on risk. Next, relevant findings from decision-making studies on risk are mapped out before decision-making relevance in relation to IO is portrayed.

2.3.1 Historical aspects

Initially, financial aspects were established as the motive of all human judgements calls. This belief is presented in several normative decision-making theories, such as the expected utility theory (Plous, 1993). Expected utility theory originated from a book called *Theory of games and economic behavior* by mathematician John Von Neumann and economist Oskar Morgenstern, published in 1947 (Dawes, 1998). The theory is founded upon an extensive, fundamental economic belief that financial traders make rational choices (Hastie and Dawes, 2001). Then, in 1976 Baruch Fischhoff, Sarah Lichtenstein and Paul Slovic established the academic centre of decision research on risk. Their research focused on behavioural decision theory, particularly probability judgment, risk perception and risk management. Slovic, Fischhoff and Lichtenstein are some of the main researchers involved in the development of the decision-making approach of the psychometric paradigm (Golding, 1992). In 1979 the prospect theory was published by psychologists Daniel Kahneman and Amos Tversky. It was promoted as an alternative view of the expected utility theory (Kahneman and Tversky, 1979). According to Kahneman and Tversky, the reference frame in which a choice is referred to is a central variable that affects risk. Human choices are portrayed according to reference frames of loss or gain, which influence and determine whether a decision-maker believes the choice to hold an acceptable risk limit or not (1979, 1984). According to Slovic, Kunreuther and White (1992) previous findings have discovered that aspects such as financial profit, cultural terms, decision-makers' personality, environmental and organisational conditions cannot alone explain human judgements about risk. Therefore, a more complex interpretation of decision-making about risk is needed for it to be acknowledged as a multidimensional phenomenon.

2.3.2 Relevant research findings

According to Breakwell (2007), all judgments involve risk to some extent as the decision-maker has to consider the possibility of uncertain consequences or losses. Plous (1993) explains how the human decision-making process about risk usually portrays two aspects: first, what and who does it concern; second, what and how to choose. Rational problem solving strategies and heuristics are often portrayed as two of the most utilised decision-making processes. However, they tend to be under the influence of bias and predictable irregularities. For instance, people tend to overestimate rare incidents like plane crashes and nuclear accidents while minor, more frequent events, which often happen at home or at the office, are underestimated (Garland, 2003). Rational problem solving strategies identify a problem and then analyse it according to every potential influential positive and negative aspect. Since it is difficult to obtain all the required information, the process is often incomplete and people settle with decisions they find good enough but not necessarily ideal (Kobbeltvedt and Brun, 2005).

Heuristics are various types of shortcuts used to reduce the complexity of a judgment process concerning risk (Fiske and Taylor, 1991). For instance, when information is inadequate, absent or ambiguous, heuristics can function as simple but effective guidelines (Hastie and Dawes, 2001). According to Fiske and Taylor (1991) the three most common heuristics are:

- *Representativeness,* which is concerned with probability judgment. For example, it is typically expected that an objective A belong to category B, if A resembles B in some way.

- *Availability* is concerned with frequency or probability judgments. For instance, estimations are often offered on the basis of how often something happens, and how quickly one can remember this event.
- *Adjustment and anchoring* are concerned with estimations of position on a dimension, like evaluating a person's efficiency on account of one's own level of efficiency.

Even though the outcome might prove negative heuristics are often chosen as rational problem solving strategies because they are faster (Bjørklund, 2005). Moreover, the risk related judgments seem to be influenced by governmental, as well as individual, logical explanations and perspectives. The following two aspects have been acknowledged as significant risk judgment components factors: 1) risk perception, which is believed to be a central component related to individuals' comprehensions, attitudes and estimations about risks and hazards (Breakwell 2007); 2) emotions, especially affects (Loewenstein *et al.*, 2001; Kobbeltvedt and Brun, 2005). Much of today's research on individual decision-making about risk seeks to understand which processes make up the base when people use information, and the significance of emotional components (Renn, 2008).

2.3.3 Decision-making and IO

According to Ringstad and Andersen (2007) a central premise underlying the entire Norwegian petroleum industry's IO focus is the belief that IO will improve decision-making and lead to safer and more efficient operations. A number of IO characteristics for improved judgment calls have been outlined, such as utilisation of real time data, increased interdisciplinary collaboration, enhanced work performance from remote locations and parallel work mode. However, concerns have also been mentioned in relation to IO and decision-making. Examples include: employees' being negative about change; unclear areas of responsibility due to choices made in groups or across distributed teams; information overload; decreased rig understanding due to relocation of personnel; increased complexity diminishing an overview.

2.4 Complex organisations and the risk of major accidents

This subsection draws attention to central organisational aspects regarding the risk of major accidents.

2.4.1 Increased focus

Major accident studies in relation to complex technology have been a central research area for decades due to catastrophes like Chernobyl[9] and Piper Alfa[10] (Haukelid, 1999; Lancaster, 2000; Reason, 2008). Following the Alexander Kielland[11] accident the Norwegian petroleum sector initiated an extensive focus on major accidents as they are considered a threat to companies' goal achievement as well as to society in general. According to the Petroleum Safety Authorities Norway[12] (PSA) major accidents usually arise as a sudden incident, such as oil spillage, fire or explosion, with serious consequences like damage to people and/or loss of human lives, serious environmental damage and/or loss of financial assets, emerge (PSA, 2010e). To develop preventive measures petroleum companies need to be aware of their responsibilities and requirements (PSA, 2010c). In the summery report of 2009 the PSA announced "there have been no major accidents, by our definition, on installations on the Norwegian Continental Shelf after 1990" (PSA, 2009, p. 14). However, the recent accident that took place at international levels as the oilrig Deepwater Horizon exploded, caught fire and sank in the Gulf of Mexico mid-April this year, has brought about a fresh concern for major accidents in the industry. The rig was owned by Transocean the world's largest offshore drilling contractors, and leased by BP, the UK's largest multinational oil company. In the accident eleven workers lost their lives and several were wounded. Continuously, significant environmental damage is expected, as the rig presumably leaks 8,000 barrels of oil each day (BBC, 22.04.2010). Immediately after the accident, PB several times unsuccessfully tried to stop the enormous oil spillage. As a result, the accident is now considered the worst in US history with the recent numbers that indicates an oil spill between 35.000 and 60.000 barrels a day (BBC, 21.06.2010).

Following the Deepwater Horizon accident the PSA reported that it was impossible to specify assessments or comparisons to Norwegian requirements or conditions, since it is still unknown what caused the accident in the Gulf of Mexico. Subsequently, it was stressed that

[9] The Chernobyl disaster is a nuclear accident that occurred in Ukraine on the 26th April 1986 (Reason, 2008, p. 49).

[10] On the 6th July 1988 the Piper Alfa platform exploded and caught fire, killing 167 people (Lancaster, 2000, p. 119).

[11] The Alexander Kielland accident is considered to be the worst since the Second World War. The platform collapsed into the ocean at night on the 27th March 1980. Of the 212 offshore personnel 123 died (Lancaster, 2000, p. 105).

[12] The Petroleum Safety Authorities Norway is the regulatory authority for technical and operational safety at the Norwegian petroleum sector (PSA, 2010a).

petroleum companies at the NCS need to be attentive to the ongoing investigation as petroleum companies have individual responsibilities to carry out risk assessments on the basis of all available knowledge, including international incidents (PSA, 2010b). In this respect the statement from Offshore Magazine might be of some interest. Accordingly Deepwater Horizon had been utilizing a new system called e-drilling since the end of 2002, that monitors drilling equipment in near real-time to reduce the rigs downtime. E-drilling was continuously stated as developed by Varco International[13] and the industry's first system for remotely monitoring and diagnosing Varco equipment on oilrigs anywhere in the world. E-drilling would transfer data via an Internet link to a manned service center based in Houston, Texas. The center holds a staff of trained technicians and engineers that monitor rig activities 24 hours a day and offers remote problem-solving by communicating monitoring, maintenance, and trouble- shooting information to the workers on the rig. As a result, drilling companies would be able to maximize equipment operation and minimize downtime (Offshore, 2002).

2.4.2 Man, technology and organisation

The ongoing expansion of ICT, globalisation and diversity are often characterised as the basis for numerous organisational demands, challenges and transitions that have originated during the past decades (Haukedal, 2005). Increased complexity at the industrial work arena and more demanding work environments are considered likely originators of both minor and major hazards. Consequently, many organisations methodologically try to outline which serious actions need to be carried out to identify risks and prevent them from surfacing (Furnham, 2005). Reason (1997) stressed that sever accidents in complex organisations usually originate on the basis of errors or because defence barriers have been bypassed. Man, technology and organisation (MTO) are portrayed as likely and implicating factors. Ringstad and Andersen (2006) describe the three concepts as follow:

- *Man* denotes human factors like motivation, skills and abilities.
- *Technology* embodies tools and facilities.
- *Organisation* refers to formal and informal communication patterns, procedures and culture.

[13] "Varco International Systems is the industry leader in the design and manufacture of Top Drive drilling systems, with more than 600 currently in operation. Varco also leads in the development of automated and semi-automated pipe handling and transfer equipment" (The Subsea Oil & Gas Directory, *Varco International,* 2000-2009).

The need to understand employees' mindsets has grown during the last decade, as several of today's complex organisations use intricate technological innovations together with a tremendous demand for human expertise. These factors challenge a company's staff and force management and employees to conceptualise new ideas in terms of action (Parker, 2008). Human errors are portrayed as one of the most common reasons for accidents at work, often caused by aspects such as extreme cognitive demands combined with stress (Furnham, 2005). Additionally, aspects such as weakened cross-disciplinary communication and lack of competence might influence and increase the potential for human errors (Breakwell, 2007). However, technical factors such as maintenance management, levels of automation, man/system interfaces, engineering control design and hardware are also portrayed as potential factors for major accidents (Reason, 1997). According to OLF (2005) facilitation of automatic processes and implementation of digital service following IO, will require a new conceptualisation of MTO that can clarify how virtual organisations behave when fields are operated across geographical borders by the use of new multimedia, visualisation and cooperation tools, as well as in relation to complex control and optimisation solutions. Ringstad and Andersen (2006) stress how MTO as a key concept, in combination with new work forms and work processes of IO, might generate easy and robust channels for IO communication with beneficial HSE effects.

2.4.3 Competence and experience

Reason (1997) stated that if an unexpected situation demands action improvisation on the basis of previous knowledge and experience might be the employees' only solution. Thus, lack of competent, experienced personnel might contribute to increased risk of major accidents. According to OLF (2007) IO are moving in the right direction, but greater progression is desired as the main focus so far has been directed at business and strategic processes, concerning generation 1. In contrast, little effort has been made towards generation 2. In order to succeed with the complex socio-technical interaction of generation 2 competence is portrayed as a key element. Furthermore, experience and competence are put forward as major obstacles when aiming for generation 2 and work forms based on interdisciplinary cooperation in real time. The reason being that lack of competence will make it difficult to illustrate the gains of IO needed to accelerate the process (OLF, 2007). Tveiten, Lunde-Hanssen, Grøtan and Pehrsen (2008) explain that there seem to be important connections between vital IOs changes and the risk of systemic accidents[14]. It is furthermore emphasised that at the moment adequate knowledge about these connections are absent. However, some knowledge is claimed to be available through research while some knowledge has to be gained through practical experience and assessments made throughout individual companies. Nevertheless, utilising open forums as an arena to share knowledge about previous experiences might become a preventative measure.

2.5 Risk Management

This subsection will outline relevant theoretical risk management perceptions, and present challenges in the petroleum sector at the NCS.

2.5.1 What is risk management?

All technological organisations like those in the petroleum industry expose people and assets to danger. Consequently, different types of protection are required, such as layers of defences, barriers and safeguards that are solid enough to withstand both natural and manmade hazards (Reason, 1997). Risk management is one of the greatest challenges that need to be met if safe and healthy work environments are to be maintained (Perez-Floriano *et al.*, 2007). According to Breakwell (2007) risk management is concerned with managing circumstances created by the company itself as well as external hazards that might damage the company as a whole. The Petroleum Safety Authorities Norway (PSA) states the following about risk management:

> *"Risk management is about evaluating, prioritizing and directing the resources to the most gainful areas. Managing risk assumes recognition of its existence - and understanding of what the risk consists of. There is risk related to any activity managed by people, and it is important to be conscious of this risk and deal with it. All efforts to prevent accidents and undesirable incidents from taking place are about managing risk. Thus, it is impossible to manage risk if we do not know which elements risk consists of, and which incident mechanisms may take place"* (PSA, 2010d).

[14] "Systemic accidents or disasters are accidents we remember and hear about for years after the event. They leave a mark in the shape of changes to regulations or work procedures, or in the shape of companies losing their reputation or substantial assets"... "Systemic accidents often involve the loss of many lives, such as in the Alexander Kielland and Piper Alpha disasters."... They... "also include accidents with a great impact on society or the environment such as the Longford disaster" (Tveiten *et al.*, 2008, p. 5).

2.5.2 Rules and regulations

According to Perez-Floriano *et al*. (2007) three different authorities are usually responsible for managing risk in companies and organisations: the company management, the government and the company's federation. However, the company is often perceived as the main responsible party. Haukelid (1999) stressed how the Norwegian petroleum industry was previously influenced by Safety Management Philosophy, a philosophy that originates from management theory and was introduced in the sector during the 1980s. The following principles were some of the central regulations:

- Management was responsible for all safety aspects, and their involvement in security matters had to be observable.
- Security was to be controllable and all accidents avoidable.
- Security was portrayed as just as important as production and quality.

Today, guidelines on the regulations about the petroleum sector at the NCS are often influenced by national standards like NORSOK, DnV and OLF, and international standards such as ISO, IEC, EN (SPA, 2010h). In relation to risk reduction the PSA Framework Regulations[15] state:

> *"Harm or danger of harm to people, the environment or to financial asserts shall be prevented or limited in accordance with the legislations relating to health, the environment and safety, including international requirements and acceptance criteria. Over and above this level the risk shall be further reduced to the extent possible. Assessments on the basis of this provision shall be made in all phases of the petroleum activities"* (Framework Regulations, section 9).

However, at the moment, no overall IO-regulations exist because the new operating practices are being implemented by the industry itself, and because it is still not clear what the new technological opportunities and changes of IO will signify. Responsibility of IO therefore rests upon individual companies. However, the PSA seeks to make sure that different players within the sector are aware of their areas of responsibility. This concerns onshore functions that are safety-critical for work offshore and vice versa. Since specific IO changes may involve new divisions of responsibilities and/or roles, as well as the transfer of decision-making authority across time zones and cultural or national boundaries, the PSA's goals are to

[15] The Framework Regulations constitute the basic frame of reference for all other regulations issued by the PSA (Tveiten *et al*., 2009, p. 8).

identify how the development of IO will affect aspects such as work processes and arrangements of petroleum activities (PSA, 2010g).

2.5.3 Risk management strategies

To manage risk organisations need to develop strategies that can be used to locate the variety of elements that comprise hazards (Reason, 2008). Risk management strategies are usually developed by identifying problem and problem areas that correspond with a company's objectives. Probability assessments of different risk aspects are then carried out, which present a variety of different solutions. The organisation then decides which actions to initiate, implements them and evaluates the final results (Breakwell 2007). Since protection of health, safety and the environment is a collective responsibility risk management strategies should be integrated within all areas of an organisation. Thorough planning, organising, implementation and control of the various hazards are required (Wentz, 1998).

According to OLF (2007), risk management strategies in the petroleum industry at the NCS are usually concerned with barriers and barrier thinking. The PSA explains how barriers are systems or operations that can prevent or reduce consequences of undesirable incidents. Moreover, they can either be denoted as physical of non-physical barriers. Non-physical barriers refer to operational or organisational barriers. However, all barriers tend to include at least one physical barrier element, for example a valve. Overall, "barriers are implemented into design and procedures, according to rules and regulations, with the objective of diminishing risk to personnel, materiel and the environment"[16] (PAS, 2010f). According to Tveiten *et al.* (2009) established barriers should reduce the probability of accidents and/or outline how to limit possible harm and nuisance that may follow from failures and defined situations of hazards and accidents (DSHA). The PSA claim that none of the DSHA for major accidents at the NCS has entailed fatalities in the last two decades. The last time fatalities were associated with one of a major accident's DSHA was in 1985 with the shallow gas blowout on the rig West Vanguard (PSA, 2009, p. 14).

According to Tveiten *et al.* (2009) speculations regarding whether or not current DSHA sufficiently would prevent hazards when full-scale IO is implemented, have been uttered.

[16] Translation from Norwegian to English by the author (PSA, 2010f).

However, the existing DSHA are mainly believed to be sufficient as IO change's supposedly only impact minor initiating events, and not the top events[17] that the DSHA are set to handle. As a result, developing IO-specific DSHA has been considered unnecessary as petroleum companies claim not to have detected any new incidents or accidents that could negatively affect humans, the environment, material or the reputation of IO. Nevertheless, Tveiten *et al.* (2009) found that new ICT-specific DSHA might become necessary as new risk aspects related to the transformation of ICT between offshore and onshore are likely to emerge. For instance, ICT-based process-control systems, power and ICT failure in control rooms can lead to both criminal and accidental events. Apprehensions regarding ICT problems due to IO were already expressed by OLF in 2005 as the common information security framework following the utilisation of the required digital networks of generation 1 and generation 2 processes were lacking (OLF, 2005). Consequently, Information Security Baseline Requirements (ISBR) for ICT systems in process control, safety and support networks were developed. The controls for ISBR should work in addition to a company's own information security policy and regulations, as well as the national legislation (OLF, 2006a). Still, scepticism towards ICT security and IO exist. For instance, the autumn 2009 edition of the scientific magazine GEMINI featured an article stating that petroleum companies' data security is inadequate because of the extensive use and trust in the internet by IO. With IO contact between offshore and onshore will become transparent. The sector is therefore at risk of attacks by hackers, viruses and worms (GEMINI, 2009, p. 10).

[17] Top events are those that imply or may lead directly to fatalities, damages, etc (Tveiten *et al*., 2009, p. 2).

3. Method

This section outlines various aspects of the data collection and analysis and accounts for the choices that have been made during the research process.

3.1 Study objective

The primary objective of this study was to outline how people from different expert groups, connected to the oil and gas industry at the Norwegian Continental Shelf (NCS), perceive risk and what their risk management suggestions are concerning the implementation of integrated operations. In what ways do the respondents seem to think in the same manner? In what ways are their perceptions different? By mapping out what the respondents' impressions and concerns are it was intended that the findings would generate ideas and information which can be used as a basis for suggestions on how employees in the petroleum industry could avoid or manage problems due to the risk of integrated operations (IO). Having applied the relevant theory and examined the relevant literature from the academic fields of risk psychology and integrated operations a suggested answer to the research question stated below will be presented later in the report.

3.1.1 Research question and research areas

The research question is:

> *How do actors from different expert groups perceive risk and risk management in relation to petroleum production in an integrated operations environment?*

However, because of the size of the research question, some limitations were needed. The following five research areas will provide an answer to the subject matter in question:

> *1. Experts' knowledge about integrated operations:* This area provides an overview of: a) what specific IO expertise each interviewee in the four expert groups possess; b) what expectations and possibilities do they have towards IO.

> *2. Definitions of risk:* These are outlines of how each actor in the four expert groups defines risk.

3. Hazards and vulnerabilities of integrated operations: Participants' risk perception of which hazards and vulnerabilities IO might inflict upon the industry.

4. Major accidents and integrated operations: Participants' risk perception of major accidents and IO with regard to aspects such as: general concerns, known or unknown risk aspects, feared magnitude, increased ICT demands and the probability of a major accident happening within the first ten years of using IO.

5. Risk Management and integrated operations: This area is concerned with a) the necessity of an ICT-specific DSHA; b) what challenges the actors believe IO may impose on the industry in relation to risk management; c) suggestions on what can be done to improve risk management following IO implementation.

3.1.2 Scientific view and research position

More information is needed before good bases for preventative actions can be obtained and the gap between IO in industry and academia can be bridged. With this study it is assumed that the field of risk psychology will contribute to the RIO project's objective with information about human perception and the management of risk. This broader objective is valuable for the overall project goal and provides some new and challenging findings that could contribute to improving solutions.

According to both Silverman (2006) and Langdridge (2006), the course of action a researcher chooses to use and follow, in order to plan and execute a research study, tends to be influenced by prior knowledge and experiences about the world and the topic under investigation. By performing this research study, I believe it is possible to gain insight about the participants' risk perception of integrated operations, and to say something significant about how risk is understood by them.

3.2 Choice of method

The research question and problem areas tend to define the study's course of action with regard to which people or situations should be studied, what methods to use and how to do the analysis (Thagaard, 2003). A qualitative approach focuses on the variety of qualities a phenomenon possesses and is often concerned with handling meanings, which is mainly expressed through language and actions (Ashworth, 2008). Due to the objective and research question of this thesis it was decided to pursue a qualitative approach through the use of semi-structured interviews.

3.2.1 The qualitative research interview

"Interviews are, by their very nature, social encounters where speakers collaborate in producing retrospective (and prospective) accounts or versions of their past (or future) actions, expectations, feelings and thoughts" (Rapley, 2007, p. 16).

The semi-structured interview is one of the most common qualitative techniques, and is also known as the qualitative research interview (Silverman, 2006). In order to answer the research question it was necessary to gain insight into how people within the petroleum industry perceive risk in relation to IO and what their risk management suggestions' are. Therefore, the semi-structured interview was chosen because it seemed like the most beneficial method to gather data. According to Thagaard (2003) the method is able to provide data on how respondents understand experiences and events in their own lives. Silverman (2006) emphasises how the method is particularly useful for accessing individuals' attitudes and values. He further explains that, when done well, one may achieve a level of depth and complexity that is hardly available through other approaches. Thagaard (2003) also draws attention to the fact that questions and topics in a qualitative research interview are often prepared in advance, but it is open to sequential changes in an attempt to stay with the respondents' stories. By doing so I was able to make room for valuable information that was difficult to foresee. In addition, the flexibility made it possible to construct the questions so they matched the uniqueness that each participant brought to the study.

3.2.2 Methodological approach: Grounded theory

Prior to working on the thesis I knew little of IO in the oil and gas industry, and therefore wished to use an explorative method that allowed for my ignorance and naivety. I felt that Grounded theory by Strauss and Corbin (1990) provided the guidelines best suited for this starting point. According to Strauss and Corbin (2008) a "grounded theory" is a theory that is discovered, developed and provisionally confirmed through systematic data collection and a systematic analysis of the gathered material. The theory's intense focus on people and its ability to generate meaning, action and intention, as well as its vision of gaining knowledge by stepping into the data, opening it up and getting in touch with it, matches the objective of this thesis. Grounded theory provides explicit strategies on how to do a research study, including how to collect, analyse and treat the data material, but it became clear early on that I could not follow all of the method suggestions continuously. This decision was made due to interest in the RIO-project. Kvale (1997) emphasises the importance of being aware that one's methods and research techniques only provide guidelines to work by. They do not decide the process, but should rather be incorporated into it. I chose to relate to this statement, and therefore had Grounded theory's vision in mind throughout the entire process, but only used some of its techniques as guidelines when coding and analysing the collected data material.

3.3 Research design, approach and selection of interviewees

The research design of this study was developed on the basis of the RIO-projects' interests and needs, together with some of the project personnel. The study arose due to interest in how people who belong to different expert groups within the petroleum industry understand risk within the environment of IO. In other words, this thesis is designed as a case study. According to Thagaard (2003) the main characteristic of a case study is to gather and examine information through a few cases or entities (for example, persons, groups or organisations). Moreover, it was stated that the main objective of a case study is to gather rich data about the subject matter in question, while also having a comparative focus if the purpose is to do comparisons between different cases.

The participants in this survey were selected based on their connection to companies within, or in relation to, the petroleum industry on the NCS, and with regard to personal experience and/or knowledge about integrated operations. The study sought participants from different areas of the petroleum sector with various IO-expertise. Interviewees were found by help of the project manager of RIO and some of the project personnel. They provided me with names of potential respondents. The respondents were contacted via e-mail, and most of the feedback was positive. People who did not reply within a week were contacted again by phone. A couple of those how were first contacted claimed to be inadequately skilled to participate in this study. However, they immediately recommended colleagues who might be interested, and put me in contact with them. Selecting interviewees in this manner is often referred to as collecting a convenience sample. The sample is also strategic as the respondents are chosen because they possess qualifications of relevance to the problem area and because of their availability to the researcher (Silverman, 2006).

The e-mail each participant received contained a brief description of the thesis, including the research question, objective and purpose of the study. I also included some general information about the collaborating partner and RIO-project and a time estimate for how long a potential interview would take. The purpose of this e-mail was to prepare the respondents by clarifying which frames and contexts the interview would hold in advance. When the day of a scheduled interview approached the respondent in question was contacted and asked to confirm the proceeding went as planned. Kvale (1997) indicates that respondents should be provided with an interview context both prior (briefing) and following (debriefing) the interviews. A debriefing did not seem necessary in this case, but after each interview the respondents were asked if they had anything to add or something was unclear, in order to provide a summary and avoid ending the meeting too abruptly.

Thirteen interviewees participated in this study. The respondents were divided into expert groups based on their current place of work (see table 1). It is necessary to keep in mind that the respondents do not speak on behalf of the company or organisation they belong to, but simply speak on behalf of themselves and share their individual opinions and thoughts. According to Thagaard (2003) it is important that a qualitative study is not too large. It should be possible to perform profound analysis of each response. A total number of 13 respondents, within categories of approximately equal size, are therefore considered sufficient to gain insight on the research area in question.

Table 1. *An overview of the categorisation of the study's 13 participants and how they were interviewed.*

<u>Group A: Industry</u> - R5 (telephone interview) - R7 (videoconference interview) - R8 (face-to-face interview) - R10 (telephone interview)	<u>Group B: Researchers</u> - R3 (face-to-face interview) - R4 (face-to-face interview) - R13 (telephone interview)
<u>Group C: Supervisors</u> - R2 (face-to-face interview) - R11 (videoconference interview) - R12 (telephone interview)	<u>Group D: Risk Analysis Consultants (RAC)</u> - R1 (face-to-face interview) - R6 (face-to-face interview) - R9 (face-to-face interview)

3.4 Creation of the interview guide

The interview guide for this thesis was semi-structured. According to Rapley (2007) a semi-structured interview normally has a fixed set of questions, and subject areas ready prior to the interview being carried out. Creating the interview guide was an interesting process. Initially it was necessary to acquire up-to-date information on the subject matter, which was obtained through reading the relevant literature. I also attended a couple of IO and risk related conferences. Thereafter a first draft of the interview guide was developed and e-mailed to the RIO-project's manager, some of the project's personnel, and my supervisory professor. I received criticisms and tips for improvement from all parties. A revised second draft was developed and distributed for comment. Based on feedback on the second version final themes and questions were settled upon.

The interview guide was developed according to the four main topics identified as central and necessary to answer the research question. Thagaard (2003) describes how one of the goals of qualitative interviewing is to get in-depth information about the subject matter. One should therefore ask questions that are easy to reflect upon and provide full answers to. In order to make sure the interview guide had accurate questions, able to gather information on the topic under consideration, a couple of pilot interviews were performed prior to the first interview. Wengraf (2001) draws attention to the fact that a semi-structured interview guide often requires additional preparation because, based on the interviewees responses, the researcher needs to be prepared to both improvise answers and originate follow-up questions at all times. Since the interview would be semi-structured it was important to be open to unexpected statements. I therefore spent a lot of time considering which aspects, among the central topics, would be interesting and worthwhile to pursue in order to capture the varying perspectives brought out through the interviews.

3.5 Conducting the interviews

The interviews were carried out one to one in the language preferred by the interviewee. According to Thagaard (2003), this is the most common approach for an interview. However, the interview surroundings were not identical throughout the 13 interviews. Three different proceedings were used. Seven interviews were conducted face-to-face, two were conducted using video conferencing equipment, and four by telephone (see table 1). All of the required telephone and video conferencing equipment was made available, by the collaborating partners within the RIO-project, at SINTEF's offices in Trondheim. The reason three different interview settings were chosen had to do with economy and convenience. The face-to-face interviews were conducted at the stakeholders' offices, as I wanted to disturb the respondents as little as possible and avoid inconveniencing them by obliging them to travel. No funds were available to cover travel expenses to meet the remaining six respondents face-to-face, due to the distances involved, so these interviews had to be conducted in a different way.

Allowing respondents to be in familiar surroundings during interviews hopefully made them feel relaxed and comfortable. Thagaard (2003) emphasises how the fundamental objective of an interview is to create an atmosphere of trust that enables interviewees to relax and share information about a pursued topic. Yet, it is important to be aware of the fact that using three different interview settings may have influenced the data material and hence the results. According to Rapley (2007), the use of ICT equipment like videoconference and telephone may influence the collected data. In this study all of the collected data material is treated equally and analysed accordingly. However, the possibility of biased data, and hence results, are taken into consideration later in the discussion in section 5.

When conducting the interviews I stayed mainly within the pre-developed categories and questions of the interview guide. However, when the respondents mentioned unclear or vague topics I asked for clarifications. In that way, the necessary explanation about a topic or aspect was provided by the respondents themselves. Langdridge (2006) stresses how the semi-structured interview does not need to stick to the interview guide at all times, but can be altered during the interview to be in accordance with the respondent's story. If an interviewee starts on an interesting digression the interviewer is free to put forward follow-up questions as he or she sees fit, before returning to the interview guide. Kvale (1997) emphasises the importance of letting the interview be fairly open in order to acquire valuable information that the researcher had not thought of in advance. Each interview lasted from 30 to 60 minutes, and was tape-recorded. The respondents had approved of this in advance. The interviews were carried out between the 3rd of November and the 21st of December 21st 2009.

3.6 Data material and analysis

Immediately after an interview was carried out the entire conversation was transcribed as accurately as possible. When all interviews were transcribed the material was divided thematically. The themes were rooted in the four problem areas developed to answer the research question, and they also provided the structural baseline of the interview guide. The coding and analysis techniques made use of in this study were developed according to the principles of Grounded theory (Strauss & Corbin, 1990). These techniques provided a guide for defining meaning and developing categories.

The analysis was conducted thoroughly. The first step was to read the transcripts of all 13 interviews to get an impression of what the material contained. Thereafter, in accordance with the guidelines of Grounded theory, each interview question was coded and meaningful thematic categories were developed on the basis of respondents' answers. Each category was assigned a colour and the interview statements that matched the topics were coloured accordingly. On the basis of the categories some tables were developed to ensure a good overview of the results. At the end, tables and categories were translated to English and compared with statements in the transcriptions to make sure the meaning had not been altered.

3.7 Credibility, confirmability and transferability

According to Trochim (2001) three important criteria need to be fulfilled and thoroughly emphasised in a qualitative study: credibility, confirmability and transferability.

Thagaard (2003) explains how the criterion of credibility in a qualitative study is concerned with the trustworthiness of a study, which can be strengthened if the researcher clearly distinguishes between information expressed in the research field and the researcher's own evaluation of it. In an effort to obtain data free from my own assumptions all of the recorded interviews were transcribed word for word. In this report quotes and stated information were also translated to the best of my ability from Norwegian to English. According to Trochim, (2001) translation of collected data material always constitutes a challenge for the researcher as it may influence the credibility of the findings. By using some direct quotes when outlining the results after conducting the analysis, a clear distinction is made between respondents' statements and my interpretations of them. My interpretations are presented as reflections or comments on the quotes and retellings, but are not detached from them. The direct quotes have been used within a thematic context as similar as possible to the one in the interviews. However, the included quotes have been selected and may therefore subjectively influence the results. Not all respondents are quoted on every topic, and on several occasions when interviewees mentioned the same concerns, they are cited as *all* or *several*. It is important to stress that consensus among the respondents is not an issue here. When interviewed all respondents had the opportunity to speak freely within the frames of the interview guide. Participants were informed in advance that they were granted full anonymity and the researcher made sure that videoconference interviews were not taped. In addition respondents were told they could withdraw from the interview at any time.

The criterion of confirmability denotes to what extent the researcher is able to be critical of their own interpretations and support from findings of other researchers. Several strategies are available for improving this criterion. For instance, one could document every procedure in order to monitor the data (Trochim, 2001). Consequently, the theoretical framework of this thesis seeks to provide solid and detailed information about central perspectives related to the research question of this thesis. Additionally, the method section focuses on systematic interpretations, especially regarding openness related to choices of process, method and conduct. A detailed monitoring of these aspects would strengthen the study's confirmability (Trochim, 2001).

Thagaard (2003) emphasises how the criterion of transferability refers to the interpretations developed within the frames of a given research project and how these may be relevant in another setting. As a researcher one has to ask oneself "To what extent does my result provide any meaning beyond the given circumstances of this particular study?" Even though the selection of respondents within this study has limitations it is possible to outline how these specific actors perceive risk of IO within the Norwegian oil and gas industry. Whether the participants of this study provide any general information on the subject matter, beyond what is true for them, is up for debate.

3.8 Ethical considerations

Prior to the interview respondents received information about their rights and the terms of participation. This was done through a written declaration of consent that accounted for the purpose of the study and explained how the collected data would be presented (see appendix 1). All respondents signed the declaration and participated on the basis of voluntary, informed consent. According to NENT (2006) voluntary consent means that respondents participate without any external pressure or limitations on their free will. Silverman (2006) states informed consent means that participants have the right to know that they are being researched, the right to be informed about the nature of the study, and the right to withdraw from the study at any time. Thagaard (2003) emphasises how the foundation of any research study is the participants' written consent. This will usually supersede any later denial of voluntary and informed consent. Another important ethical research principle outlined in NENT (2006) is the requirement of confidentiality. It states that those who agree to be scientific subjects have the right to know that all personal information that is revealed is treated with total confidentiality. The research material needs to be completely anonymous and impossible to trace back to its originator/s.

In this thesis all respondents are ensured full anonymity. In order to perform this guarantee the name, sex, age, place of residence, work site and specific information about work tasks, are not revealed. All of these aspects are considered to contain critical information that, if they were included, might diminish the participants' anonymity. In an effort to distinguish interviewees while providing anonymity each respondent is given a random number from one to 13. For instance R2 means respondent two (see table 1 above).

In the analysis it also felt natural to mention a person by gender. Therefore, respondents numbered R1 to R7 are referred to as him and those numbered R8 to R13 are referred to as her. These references do not represent the respondents' actual gender. The decision is purely practical and a contributor to anonymity. According to The National Committee for Research Ethics in Science and Technology (2006) it is important that the researcher is aware of the scale of consequences participating in a study might have upon a respondent. Hence, the respondents' were promised full anonymity. In Thagaard (2003) it is stressed that the interviewer should not claim possession and rights to audio recordings and transcribed data material for the foreseeable future. Therefore, the signed declaration of consent stated that the interview recordings will be used only for the original purpose and only the researcher will have access to them. Furthermore, it was stressed that the audio recordings, transcriptions, and notes will be destroyed when the thesis is submitted.

4. Results

In this section, research findings from the conducted interviews will be outlined on the basis of hierarchic, thematic analysis of the interview transcriptions. The results will be presented through direct quotes and retellings of the respondents' answers, as well as being compared and commented upon.

4.1 Experts' knowledge about integrated operations

This subsection contains two parts. Initially, the four groups' knowledge domains, in regard to integrated operations (IO), are presented. Next, the participants' thoughts regarding possibilities and expectations of IO are given.

4.5.1 Areas of expertise

As pointed out in the theory section, the concept of IO is quite complex and the setting in which it appears and its use pretty much define what it means and what it constitutes. To fully understand the respondents' perceptions of risk in relation to IO one needs to know what kind of experience and knowledge they possess about it. For this reason the IO expertise present in each of the four expert groups is outlined.

Expert group A, industry, consists of four members. Two of them claimed to know a lot about HSE issues in relation to IO. They emphasised that they had gained their knowledge through work experience with IO. In addition, one of them claimed to possess IO knowledge in another area. He phrased it as follows:

> *"My knowledge domain is mainly aimed at organising managements' ways of working and how this contributes to the company's IO work. I also work a lot with HSE in relation to IO, especially human factors within IO concerned with the construction of work sites"* (R5, industry).

The two remaining group members claimed to possess modest knowledge of IO because of limited relevant work experience. One respondent phrased it thus:

> *"I don't really know what my knowledge and experience within this area are. I know what I can within the business and risk management, but with regard to IO I'm not quite sure"* (R8, industry).

The four group members' statements reveal that each of them possesses different knowledge about IO. In addition, their work experiences with IO vary. Two of them are experienced, while the other two are inexperienced.

In expert group B, researchers/professors, another pattern of expertise seems to be present among the three participants. All three mention that they have gained their knowledge through work experience with IO, but related to different factors. Moreover, their level of experience varied: high, general and low. The most experienced participant claimed to possess knowledge about equipment reliability and the required technology. In addition, he stated that he knew a lot about risk analysis and risk assessment applicable to the field of IO. The somewhat less experienced researcher claimed to possess more general IO knowledge related to organisational and security matters. The least experienced group member outlined his IO knowledge in the following way:

> *"In fact, I have only heard integrated operations being mentioned and read descriptions of it. As a result I have very little specific knowledge about the exact systems used within IO"* (R4, researcher).

Based on the researchers/professors assertions their IO experience varies but they possess knowledge related to a number of different IO factors.

In expert group C, supervisors, statements from the three group members revealed extensive knowledge and work experience with IO. One claimed to hold expertise in relation to operational systems that is essential in order to create IO. His expertise more specifically comprised data gathering, data information and data possessing systems concerning production and security. He further explained that the technical approach to this work was often referred to as managing security systems, including aspects involved in operation, maintenance and modification. One of the other group members claimed to know a lot about regulations concerning administrative IO responsibilities as well as the challenges that emerge when new systems are established, for instance integrity and robustness demands. The last member stated her IO expertise as follows:

> *"I am mainly involved in projects that report on integrated operations and examine tasks related to different problem areas. For instance, what solutions the industry chooses. I work mainly within the area of drilling and well[18]"* (R12, supervisor).

The three supervisory respondents appear to have solid knowledge about IO, although they are in different areas of the industry.

In expert group D, risk analysis consultants (RAC), all three group members stated that they possess knowledge in relation to the organisational challenges of IO. One of them outlined his familiarity with some IO work related to the possibilities of relocating control rooms onshore and risk aspects associated with this operation. In addition, he said he possessed some general knowledge on the human and organisational risk factors of IO. The next consultant outlined his areas of expertise that incorporated organisational work structure, work environment and communication between different disciplines in relation to IO. The third group member stated:

> *"Most of the tasks I have performed have been concerned with organisational challenges related to IO, but this is very broad. I have been involved in everything from problem areas of HSE, risk assessments and risk analysis to more specific organisational development issues"* (R9, RAC).

In contrast to the other expert groups the risk analysis consultants appeared to be the only group in which all members hold IO expertise with some resemblance to each other. As the categorisation of expert groups is based on current place of work these results may denote that actors within this group have the least variation with regard to IO expertise.

The respondents' knowledge domains and experience with IO are quite different within each expert group. To get a general idea of the divergence within and between experts a chart has been outlined (see table 2). The four expert groups are presented in the rows, while areas of IO expertise are positioned in the columns. It is important to emphasise that respondents with little work experience in relation to IO (located in category 6) possess IO knowledge. For instance, they hold a great deal of expertise in areas that are essential to IO such as risk management, risk and reliability analysis. These participants are therefore considered relevant to this study.

[18] Drilling and well refers to the process of drilling a hole in the seabed for the extraction of oil and gas (Aadnoy, Cooper, Miska, Mitchell and Payne, 2009).

Table 2. *An overview of group categorisation (rows) and specific areas of expertise (columns) based on responses from the 13 respondents of the interview study.*

	Areas of IO expertise: related to risk assessment and risk analysis					**Lack of IO experience:**
	1. Relocation of control rooms	**2. Organisational factors and IO**	**3. Health, safety and environment in relation to IO**	**4. Management: Regulations and IO responsibility**	**5. Equipment reliability and Operational systems of IO**	**6. Knowledge of: risk management/reliability and risk analysis**
Expert Group A: Industry			**- Expertise on IO and central HSE issues**	**- Knowledge of organising managements' IO work**		**- Expertise within risk management, but modest/no work experience with IO**
Expert Group B: Researchers/Professors		**- IO knowledge regarding organisation and security matters**			**- Knowledge on equipment reliability and technology use**	**- Some IO knowledge: have heard about and read something on it. -Work with reliability and risk analysis**
Expert Group C: Supervisors		**- Acquainted with organisational challenges following IO**		**- Knowledge of regulations and administrative IO responsibility**	**- Explicit expertise in operational ICT systems needed to make IO work**	
Expert Group D: Risk Analysis Consultants (RAC)	**- Knowledge of control room relocation and its risk aspects**	**- Knowledge of organisational development concerning IO**				

4.1.2 Possibilities and expectations of integrated operations

Based on the collected data, several positive IO beliefs where identified among the respondents. Possibilities of IO were generally perceived to occur within the six areas: finance, HSE, surveillance, operations, cooperation, expertise and decision-making.

With regard to finance, five participants (one from industry, one supervisor and all consultants) mentioned how the implementation of IO can lead to *financial growth/economic improvement* within a number of petroleum companies. For instance, expenses might decrease as travelling can be reduced. Furthermore, new technology might reduce errors and maintenance problems, which in turn reduce costs. One of the participants' explained it thus:

> *"I guess IO have potential for reducing costs for the reason that one gets more real time information about the equipment and operational status, which again enables one to step in earlier"* (R6, RAC).

In relation to *HSE*, nine interviewees mentioned improvement possibilities regarding a number of safety aspects. Three of them (two industry members and one supervisor) pointed out how safety upsides would be achievable through IO. However, they failed to specify which industry areas or what elements of IO they had in mind. Four of the others (two researchers, one supervisor and one consultant) stressed how fewer offshore personnel on a rig, due to relocation onshore, can signify risk reduction because fewer people are exposed to hazards on the rig and/or in production. The consultant emphasised how real time data may improve risk assessment, as the ability to follow up the installation will improve with IO. One of the industry members mentioned how the development of common tools might help clarify risk setting when utilising IO. The other industry member made a comment regarding work environment:

> *"I believe the new ways of working will result in increased well-being at work because human beings are most often social creatures and those who have succeeded with IO have got a very nice working environment"* (R5, industry).

The third area concerned *surveillance*. According to one industry member and one researcher IO might bring about tremendous surveillance improvements because better and constant supervision is possible. One of them stated:

> *"With IO one gets a type of status, 24/7 surveillance, situated onshore, which haven't been possible before, not even offshore. As a result the ability to sense what condition the installation is in has improved, contrary to earlier"* (R7, industry).

The fourth area, *operations,* concerned possibilities of human, technical and organisational elements. Six respondents mentioned how remote operations and the use of real time data were likely to improve operational efficiency. Three of them (one industry member, one supervisor and one researcher) explained that onshore and offshore employees will experience increased work efficiency. The three other participants (one industry member, one researcher and one consultant) emphasised the prospect of increased operating efficiency of entire installations. One of the researchers elaborated as follows:

> *"With IO one will probably get access to operating fields that were previously inaccessible. Additionally, one might operate fields more efficiently than before"* (R13, researcher).

Four participants drew attention to the fifth area, *cooperation.* Two of them (one industry member and one consultant) believed that IO will create closer dialogues between sea and shore, as well as across geographical borders. The two remaining respondents (two industry members) claimed new interactive and proactive work forms, like enhanced teamwork among interdisciplinary groups, would improve cooperation among different units. One of them elaborated:

> *"If we do this correctly, I believe we will get a much better setting for collaboration between different disciplines and work centres"* (R10, industry).

The remaining areas, *expertise* and *decision-making*, have been combined as some responses refer to them jointly and others separately. Two interviewees (one from industry and one consultant) stated how real time data and new technology will increase expertise among offshore and onshore personnel. Five others (one from industry, one researcher, two supervisors and one consultant) emphasised how increased expertise and knowledge of IO will improve ability to get help when needed, for instance in decision-making. One of them expressed it thus:

> *"IO will offer the possibility to get real time data onshore quicker, in order to provide offshore personnel with sufficient help and support in decision-making situations"* (R12, Supervision).

Findings from the interview study revealed that participants' expectations towards IO varied from non-existent to sceptical and low to very high. Two respondents (one researcher and one supervisor) claimed not to have any expectations and two others (one from industry and one consultant) expressed scepticism towards whether or not IO have been thought through thoroughly. The consultant said:

> *"IO happens a bit too fast and maybe we haven't thought enough about the purpose of it all"* (R1, RAC).

One of the researchers claimed to keep a personal distance to IO, but emphasised how she hoped it will be a success, without anything going wrong. Three other participants (two from industry and one consultant) expressed genuine optimism. The two industry members referred to IO as something they believe in and have a good feeling about. One of them referred to himself as an IO enthusiast. The consultant stated:

> *"It is very exciting to think about how you can take something as firm and boring as offshore installations and suddenly alter and renew its ways. It is exciting to see what will happen, what the next step will be"* (R9, RAC)

In addition to the differentiation between negative, neutral and positive, expectations of IO some of the interviewees expressed their expectations about areas such as working environment, operating efficiency and security. The content of these IO expectations were comparable to the possibilities previously outlined. Three of the industry members held expectations regarding how IO will provide new and better ways of working together. Two participants (one industry member and one consultant) drew attention to the prospect of IO minimising geographical distance between a number of work sites by increasing the use of real time data, videoconferencing equipment, split computer screens and work spaces. They further emphasised how these elements will enable people to cooperate, get in touch with, as well as help each other more efficiently.

Two interviewees (one from industry and one consultant) stressed how their expectations of IO focused on the possibility of increased operating efficiency. For instance, enhancing the uptake of natural recourses (oil and gas) by encouraging expertise in reservoirs, production, drilling and well to actively participate in decision-making. Furthermore, five participants spoke about their expectations of industrial security matters. Two of the industry members anticipated that IO would bring about a better security focus by developing new tools to improve the risk picture. One researcher hoped IO would enhance state surveillance. The remaining two (another industry member and a supervisor) anticipated HSE improvements in order to reduce the risk to personnel and installation; for example, accident reductions, fewer tool failures, less operation stops and fewer hiccups. In other words, regardless of some scepticism and concerns, IO were thought of as a changing possesses that hold a lot of possibilities and are the object of positive expectations.

4.2 Definitions of risk

As Renn (2008) points out, the concept of risk is highly complex and much debated throughout academic, public and societal circles. The idea of risk might, in other words, differ at personal and professional levels. In order to describe the respondents' perception of risk concerning integrated operations it is important to get an idea of how they comprehend risk in general. This subsection will outline how the different actors within the four expert groups defined risk.

Within expert group A, industry, one of the respondents emphasised that, to him, risk is the probability of unwanted incidents, which may lead to human injuries or, in the worst-case, death, environmental damage, major accident emission or loss of assets. One of the other group members outlined a similar definition of risk:

> *"What is the textbook definition? The probability of unwanted events and the magnitude of those unwanted events, as consequences, loss of personnel, materiel or economic values or damage to the environment"* (R7, industry).

The remaining two members also defined risk as probability times consequences. However, rather than elaborating on the definition they described a connection to their work tasks. In general, all four members expressed a rather similar definition of risk, and the elements chosen for elaborations are the only minor differences between the four statements.

Within expert group B, researchers/professors, all three members referred to the general textbook definition of risk, stating concisely how they usually define risk as a combination of probability and consequences. However, one of them emphasised how the incident list was an important aspect of the risk definition. He elaborated that incident lists concerning all possible, unwanted events, including bow-ties[19] for each event, are essential in order to define risk. Furthermore, he stressed the simplicity of establishing probability and consequences if an incident list were developed. He added:

[19] "A bow-tie model is a high-level modelling for risk analysis –combining the results from fault tree analysis and event tree analysis in order to explicitly establish the cause/effect relations related to unbiased events" (Nordgård, 2008, p.2)

> *"As I see it, the incident list is what creates most of the uncertainty because it is so difficult to include all of the possible events that can happen, and do damage, on it. Very often one has forgotten parts of it''…. '' If you look into an accident investigation very often it states that this particular incident was not thoroughly covered by the risk analysis done in advance. It was simply forgotten"* (R3, researcher).

Overall, the three researchers' showed consensus in risk definitions.

Within expert group C, supervisors, one respondent referred to risk as probability times consequences. He explained how the frequency or probability of a hazard is found through empirical data or analysis. The hazard's characteristics furthermore determine which consequences will occur. Another member stated:

> *"There are several academic spins on it, but to my mind, risk is the correlation between probability that an event will occur and its consequences"* (R11, supervisor).

The third supervisor defined risk as an ambiguous concept. On the one hand, it can be calculated by the use of risk analysis, such as are we above or below the accepted risk criterion. However, on the other hand, risk is experienced and alters from person to person, based on, for example, work tasks, social environment or educational background. In general, all three members acknowledged the textbook definition of risk. Yet, two of them viewed the concept as complex and one emphasised experienced risk as significant.

In expert group D, risk analysis consultants (RAC), only one member solely defined risk as probability times consequences. The two remaining consultants portrayed more complex definitions. One of them defined risk like this:

> *"The easiest I guess, is to say it is a combination of probability and consequence. This is the traditional definition, but you can of course outline its nuances by making a distinction between experienced risk and real risk. However, risk is concerned with what will happen, how probable is it that this will happen, and what the consequences will be like?"* (R6, RAC).

The other consultant also said it is usual to defined risk as probability times consequences. However, she emphasised that to her, risk is a lot of things and the technical definition is just one way of looking at it. Experienced risk, like individual levels of uncertainty, environmental risks, such as pollution and major organisational accidents were mentioned as other types of risk. In essence, she believed all of these three areas to be central and serious aspects of risk. Overall, all three consultants referred to the textbook definition of risk. However, two of them claimed the concept to be complex and stressed experienced risk as influential in a definition.

Table 3 illustrates the participants' risk definitions in such a manner that comparisons between and within expert groups are possible. The rows hold the four different expert groups, while the columns present two categorisations of risk definitions. The first category contains the majority of the interviewees and explicitly defines risk with regard to the common 'textbook' definition of probability times consequences (expected value theory[20]). The second category holds a more complex definition of risk, where the expected value is complemented by experienced risk. In general all 13 respondents mentioned how risk usually was defined as probability times consequences, while three of them additionally referred to experienced risk as a central element when defining risk.

Table 3. *This table outlines how the 13 experts who participated in this study define risk, both within and across expert groups.*

Group:	**1. Mentions the general 'textbook' definition (expected value)**	**2. Mentions both calculated and experienced risk**
Expert group A: Industry	**R5, R7, R8 and R10: Risk is the probability times consequences.**	
Expert group B: Researchers/Professors	**R3, R4 and R13: Risk is mainly the probability times consequences.**	
Expert group C: Supervisors	**R2 and R11: Risk is often viewed as the probability times consequences.**	**R12: Risk is divided in two. It can be calculated by risk analysis, but then there is experienced risk that is different from person to person.**
Expert group D: Risk analysis consultants (RAC)	**R1: Most often views risk as probability times consequences.**	**R6: Risk is a function of probability times consequences, but also one's individual experience of it.** **R9: Risk can be technical, experienced and environmental.**

4.3 Hazard and vulnerabilities of integrated operations

This subsection outlines which hazards[21] and vulnerabilities[22] the participants believe integrated operations (IO) might create, but since the concepts were used inconsistently by some of the respondents, they have been united and portrayed as synonyms.

[20] Theory about expected value originates from an approach on risky choices based on psychophysical analysis of responses to money and probability. This psychophysical approach can be traced to an essay by Daniel Bernoulli published in 1738 (Kahneman and Tversky, 1984).

[21] See section 1 for definition of hazard.

[22] See section 1 for definition of vulnerability.

When talking about a specific hazard or vulnerability it is important to know which IO setting it occurs within, as this influences and determines them. One participant called attention to this fact when he stated:

> *"Hazards have to be measured according to the level of IO and how much you depend on it"…. "The mildest forms of IO may, for example, be the use of video conferencing equipment, and an extreme form is to move important, vital functions onshore, and maybe even abroad''* (R11, supervisor).

The majority of hazards and vulnerabilities mentioned by the respondents are linked to the full range IO settings, which involves remote operations, relocation of control rooms and relocation/reduction of personnel.

Findings from the interview study identified several hazards and vulnerabilities that may come about as a result of the implementation of IO, resulting in these seven main categories: a) human characteristics, b) management, c) decision-making, d) knowledge and competence, e) communication and cooperation, f) dependence, g) system complexity and h) security.

In category a), *human characteristics*, five different hazards/vulnerabilities were identified. Six respondents (one from industry, two researchers, one supervisor and two consultants), stated *lack of hands-on feeling* as a sever hazard/vulnerability of IO. The consultant offered the following explanation:

> *"By not being offshore but onshore, you lose important hands-on feeling. If something explodes you are not able to hear it, or go outside and check if a pump is hot or making a weird noise"* (R1, RAC).

Two other participants (industry members) mentioned *lack of overview* as a negative aspect of IO. They believe that remote operations will result in problems concerning who is doing what, and hence a clear overview will be difficult to maintain. A consultant *stated lack of personnel supervision*, as another hazard/vulnerability of IO. He said:

> *"By moving control rooms onshore, you will not be able to see what condition control room personnel are in, and you therefore lose a sense of what is happening amongst the personnel, at their personal, individual levels"* (R9, RAC).

A supervisor drew attention to *altered risk experience* as a potential hazard/vulnerability of IO. She expressed a strong concern about how the risk experiences among offshore personnel left on the installations will change, because with the use of remote operations those capable of shutting down the rig will be so far away. While an industry member claimed *increased* *trust* to be a major hazard/vulnerability of IO, because relocated personnel onshore will be unable to see things for themselves, so they have to rely on what others tell them.

Category b), *management*, merely contains one hazard/vulnerability of IO. According to an industry member *increased workload* might become a sever hazard of IO. He said:

> *"As a result of management's way of organising entire companies may experience a more intense way of working and increased workload, with the prospect of exhaustion and/or burnout"* (R5, industry).

In category c), *decision-making*, two different hazards/vulnerabilities of IO are outlined. A consultant found *offshore personnel's decision-making* to be a hazard/vulnerability of IO. He claimed:

> *"With IO there will be fewer people present on the installations to make decisions on about the rig"* (R6, RAC).

In contrast, one supervisor mentioned *onshore personnel's decision-making*:

> *"Onshore personnel may be biased by the fact that they are distant from many operations, which might result in them making different decisions than they would had they been offshore"* (R12, supervisor).

Category d), *knowledge and competence*, holds seven different hazards/vulnerabilities. Two participants (one industry member and one consultant) believe remote operations cause unfortunate situations regarding *information utilization*. The industry member elaborated his concern the following way:

> *"I keep thinking about the fact that, what if one is not able to use the available information in a good enough manner? In production management, for instance, one does not have well modelling and reservoirs capable of picking up/being interactive with the information flow that is coming in"* (R5, industry)

Another industry member expressed an apprehension towards IO regarding *information availability*:

> *"In most cases I would claim that an increase in available knowledge would reduce the probability of accidents, but now, with IO, I believe it will in some cases originate unfortunate consequences"* (R7, Industry).

Furthermore, one of the industry participants assumed *lack of knowledge* about tools and colleagues might become a hazard/vulnerability of IO given that personnel are removed. A consultant believed *shifts in knowledge* will create hazards/vulnerabilities:

> *"When a lot of personnel are relocated onshore, the theoretical competence becomes important, while practical knowledge and skills are superfluous"* (R6, RAC).

Furthermore, one consultant feared IO will lead to *inexperienced personnel* running the installations, while yet another mentioned how he feared IO may create too *specialised disciplines*, which will be incapable of understanding each other. One of the supervisors was concerned with *expert dependability* and *competence dependability* as two possible hazards/vulnerabilities of IO. With regard to the first aspect he stated:

> *"Today are we dependent on a lot of different actors, like system delivery personnel, etc. Since no one has all the competence, because it has become too complex, you need a specialist for everything, and that is a vulnerability of IO"* (R2, Supervisor).

With regard to the second aspect he said:

> *"It is important to have the right people, with the right minds, in the right place at the right time. Because in the borderline between suppliers and operations the competence dependability is increasing"* (R2, supervisor).

In category e), *communication and cooperation*, three hazards/vulnerabilities of IO were outlined. Two industry members assumed IO will create hazards/vulnerabilities such as *lack of face-to-face communication*. One of them stated the following:

> *"By removing personnel we lose the human face-to-face communication and that is scary. I am fundamentally convinced that people need to talk together, to sit in different virtual spaces solving tasks"* (R10, Industry).

Two other participants (one industry member and one researcher) emphasised the fact that *too many actors* involved in the same operations will inhibit cooperation and create serious misunderstandings. The last hazard/vulnerability of category d, *interface*, were drawn attention to by a supervisor expressed her concern as follows:

> *"Having a holistic approach of how to plan and carry out operations is vital because there are a lot of suppliers that have to talk together and tools that need to be correctly connected. If the interfaces are not maintained, barriers that supposedly should work will not be good enough, and that might cause major problems"* (R12, supervisor).

In category f), *dependence*[23], three hazards/vulnerabilities were pointed out by the respondents. Four participants (one from industry, two researchers and one consultant) expressed concerns regarding *ICT reliability*. The industry participant said:

> *"I think there are a couple of ditches one might walk into by relying more and more on ICT tools, which we might not know the consequences of yet"* (R10, Industry).

With regard to the second area of concern, *system uptime*[24], one supervisor uttered the following statement:

> *"The most extreme hazard of IO is to move important, central elements onshore, maybe even abroad. With vital elements gone you are dependent on constant system uptime being 100%"* (R11, supervisor).

With reference to the third area, *fibre optic*[25] *dependency*, one industry member claimed:

> *"Due to automatic processes people forget their knowledge about general tasks, and vulnerability is then connected to the fact that one is dependent on decisions-makers on shore, who again are dependent on fibre optics in order to get the process working"* (R7, Industry).

In relation to category g), *system complexity*, five hazards/vulnerabilities of IO were mentioned: barrier loss, system complexity, increased uncertainty, errors and organisational halt. With reference to *barrier loss*, a supervisor exclaimed:

> *"The use of high range IO may result in partial or total barrier loss. The reason being that common elements such as joint communication lines/systems and computer systems appear within the structure, so control over technological and organisational aspects within the factory will be difficult to maintain"* (R2, supervisor).

One of the researchers uttered a concern regarding how *system complexity* in general may constitute a hazard/vulnerability. For instance, in relation to maintenance personnel who meet partially unfamiliar environment. The risk they are exposed to may increase since they are inexperienced with the system, such as lacking knowledge of where lifeboats are situated, and where to run if something happens.

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[23] *Dependence* is a translation of the Norwegian word *avhengighet* (Krikeby, 2003, p. 799).

[24] Part of active time during which an equipment, machine, or system is either fully operational or is ready to perform its intended function. Opposite of downtime (Business dictionary, 2010, *Uptime*).

[25] "Fibre optics enables the data transmission rate to exceed that of electrical transmission, and the weight and dimensions of the cable are minimized, reducing the effect on shipping weights and pressure drop through the coil" (Retalic, Laird, and MacLeod, 2009, p. 775).

Another researcher mentioned *increased uncertainty* as another hazards/vulnerability of IO, because when elements of uncertainty are introduced in a complex system the vulnerability increases. Two participants (one researcher and one supervisor) emphasised that increased system complexity will entail more *errors*, which constitute a hazard/vulnerability of IO. *Operational halts* were mentioned by a researcher as a hazard/vulnerability of IO. He stated:

> *"Whit increased ICT system complexity one will become more vulnerable to operational halts"* (R3, researcher).

In category h), *security*, three hazards/vulnerabilities were identified: information security, hackers and the unexpected. Concerning *information security* one member of industry claimed:

> *"The biggest hazard of IO will be information security and information security problems, mostly when using real time data, since a huge amount of information is being transferred and unforeseen errors may occur"* (R5, Industry).

Four interviewees (one form industry, two researchers and one supervisor) drew attention to *hackers* as a major hazard/vulnerability of IO. One of the researchers said:

> *"One of the greatest hazards of IO are if intruders, hackers, or other unwanted people get access to, or manage to break into the computer systems of IO"* (R4, researcher).

The third hazard/vulnerability in relation to security, *the unexpected*, was also mentioned by a researcher. She elaborated as follows:

> *"With technical operational aspects of IO one may become very vulnerable if one is not prepared for unexpected events, inflicted from the outside"* (R13, researcher).

Overall, numerous hazards and vulnerabilities were mentioned, concerning many aspects and changes related to IO. Moreover, most of the presumed hazards/vulnerabilities are related to extreme IO aspects like remote operations, remote control rooms and relocation of offshore personnel onshore. In order to get an overview of the stated hazards and vulnerabilities of IO, table 4 was put together. The left column of the table presents the main categories, whereas the right column outlines all of the hazards/vulnerabilities mentioned and clarifies which circumstances the respondents believe them to be situated in.

Table 4. *This table outlines possible hazards and vulnerabilities the respondents believe IO might inflict upon the industry.*

Key category:	Hazards/vulnerabilities	Examples
A. Human characteristics	**1. Lack of hands-on feeling** **2. Lack of overview** **3. Lack of personnel supervision** **4. Altered risk experience** **5. Increased trust**	1. "Onshore personnel lose hands-on feeling of what happens on the rig. They are not able to hear or smell what is going on." 2. "With remote operations it will be difficult to maintain a clear overview and know who is doing what." 3. "By moving control rooms onshore you will not be able to see what condition control room personnel are in." 4. "Offshore personnel's experience of risk may alter since those capable of shutting down the wells are distant." 5. "A hazard of IOs might be too much trust in what has been told you, instead of seeing it yourself."
B. Management	**6. Increased workload**	6. "As a result of management's way of organising, entire companies may experience a more intense ways of working and increased workload, with the prospect of exhaustion and/or burnout."
C. Decision-making	**7. Onshore personnel's decision-making** **8. Offshore personnel's decision-making**	7. "Onshore personnel may be biased by the fact that they are distant from many operations, which might result in them making different decisions than they would, had they been offshore." 8. "With IOs there will be fewer people present on the installations to make judgments on and about the rig."
D. Knowledge and competence	**9. Information utilisation** **10. Information availability** **11. Lack of knowledge** **12. Shift in knowledge** **13. Inexperienced personnel** **14. Specialised disciplines** **15. Expert dependability** **16. Increased competence dependability**	9. "There may be a hazard in whether personnel onshore really are capable of utilising all available knowledge." 10. "Increased availability of knowledge and information might in some cases cause unfortunate constellations." 11. "Removing offshore personnel onshore may cause them to lose knowledge about equipment and how it is used. In addition, distant personnel results in less knowledge about how one's colleague are." 12. "Theoretical competence will become important, while practical knowledge and skills are superfluous." 13. "I think it may be a vulnerability to have less experienced personnel to run an installation." 14. "A consequence of IOs may be too specialised disciplines which will be unable to understand one another." 15. "Everything will become so complicated that you will need a specialist for everything. That is a challenge for IOs." 16. "In the borderline between suppliers and operations the competence dependability is increasing."
E. Communicate and Cooperation	**17. Lack of face-to-face communication** **18 Too many actors** **19. Interface**	17. "In removing personnel one loses important face-to-face communication." 18. "Too many involved actors may result in bad cooperation and serious misunderstandings." 19. "If the interfaces are not maintained barriers that should supposedly work will not be good enough and cause major problems."
F. Dependence	**20, ITC reliability** **21. System uptime** **22. Fibre optic dependency**	20. "In general it is a hazard relying too much on technology and infrastructure not failing." 21. "I believe control rooms and all kinds of readiness operations which are dependent on constant computer connection will be vulnerable and dangerous." 22. "Automatic processes of IOs will cause offshore workers to lose knowledge about general tasks, as they become dependent on decisions-makers on shore who are dependent on fibre optics in order to get the process working."
G. System complexity	**23. Barrier loss** **24. System complexity** **25. Increased uncertainty** **26. Errors** **27. Operational halt**	23. "The use of high range IOs may lead to total or partial barrier loss." 24. "General system complexity may increase the risk of maintenance staff, who face unfamiliar surroundings." 25. "With IOs, elements of uncertainty are introduced in a complex system and the vulnerability will increase." 26. "Increased system complexity entails more errors." 27. "With increased ICT system complexity one becomes more vulnerable of operational halts, due to errors."
H. Security	**28. Information security** **29. Hackers** **30. The unexpected**	28. "The biggest hazard of IOs will be information security and information security problems, mostly when using real time data." 29. "More and advanced computer technology will increase the probability of somebody managing to break into the system." 30. "With technical operational aspects of IO one may become very vulnerable if one is not prepared for unexpected events, inflicted from the outside."

4.4 Major accidents and integrated operations

This subsection will outline the participants' risk perception in relation to major accidents and IO. Five various areas will be covered. Initially, general concerns regarding major accidents are cited. Next, known and unknown risk aspects are mapped out. Then, opinions on feared magnitude of major accidents by IO are addressed. Thereafter the interviewees' thoughts regarding increased demands on ICT and the hazard of major accidents due to IO are emphasised. Lastly, the probability of a major accident occurring during the first ten years of using IO is presented.

4.4.1 General concerns regarding major accidents

Findings from the interview study reveal many and varying opinions on whether major accidents are a likely hazard of IO. Three respondents (one researcher, one supervisor and one consultant) believed that IO will increase the probability of major accidents. According to the consultant, consequences of necessary IO changes that have not been examined enough might arise. Therefore, it may very well increase the hazard of major accidents. The researcher worried that IO would increase material damage and enhance pollution. The supervisor elaborated:

> *"I believe there is a possibility of increased risk of major accidents if IO are introduced without being thoroughly planned. One has to think about all the systems and the interdependences, if not, one is unable to identify challenges or problems that may occur again and create major accidents"* (R12, Supervisor).

Four participants (one researcher, two supervisors and one consultant) pointed out how utilising IO would have no effect on the risk of major accidents. However, IO might create challenges or problems due to increased system complexity. Their explanations as to why differed. One of the supervisors believed security problems will increase. The consultant said one's opportunity to prevent a hazard on the rig will be lessened because personnel are situated onshore. The other supervisor thought reduction of offshore personnel may alter their understanding and experience of risk and create new challenges. The researcher said:

> *"There is hardly any reason to believe the risk of accidents will be greater with IO than traditional operations, but it might be different. It may be other elements that cause it, not necessarily different types of consequences"* (R13, researcher).

The six remaining respondents (four industry members, one researcher and one consultant) believed IO will contribute to diminishing the risk of major accidents. One of the industry members stated the following:

> *"If one manages to use IO as a tool in order to simplify and strengthen the relationship between disciplines onshore and disciplines offshore, and accordingly help each other, I think it will contribute to decreased major accidents"* (R8, industry).

The others also expressed positive attitudes and referred to IO as a preventative measure. The consultant stated that IO will help operating centres maintain better control. The remaining industry member said IO will empower monitoring, surveillance, supervision, control and maintenance, which might help discover, for example leakages, much earlier.

4.4.2 Known or unknown risk aspects

The respondents' opinions varied with regard to the extent to which any risk of major accidents by IO is known or unknown within the industry. One of the researchers claimed:

> *"Whether major accidents will have a higher frequency after the implementation of IO, I don't know. I think the consequences of major accidents will probably be smaller after implementing IO since the exposure of humans will decrease"* (R4, researcher).

With regard to the same aspect, one industry member emphasised that in order to say anything specific on the subject matter IO need to be implemented and used for a while. Six participants (two industry members, three supervisors and one consultant) considered the risk of major accidents by IO to be well known within the industry. An industry member elaborated:

> *"IO are not something that is separate, but they are being integrated into the everyday business. Thus, I believe it will not increase the risk of major accidents but rather be a helpful tool that prevents major accidents from happening"* (R5, industry).

Nonetheless, some of them expressed a couple of concerns. The consultant believed offshore personnel lack knowledge of how major accidents originate and how individuals may contribute in creating or preventing them. One of the supervisors stated that although system complexity might alter with IO, due to increased uncertainty aspects, this is only a minor obstacle and not something that will cause major accidents. Another supervisor claimed:

> *"My impression is that in some environments IO are very well known, but different companies have different visions about what they want out of IO and what IO actually are. So my impression is that one has different competences depending on where in the system one is sitting/working"* (R12, supervisor).

Five respondents (one industry member, two researchers and two consultants) mentioned how the risk of major accidents caused by IO is not thoroughly known by the industry. In addition, one of the industry members stressed that the hazard's extent is unknown. The two researchers said that whether major accidents will increase or decrease by using IO is not thoroughly known by the industry yet, because as long as several aspects of IO remain hidden, the magnitude of it is unclear. The consultant stated:

> *"My impression is that there is not enough focus on major accidents today, and I guess not in relation to IO either. We are good at focusing on the little incidents, but maybe not enough on how they might develop into bigger accidents, which I believe it is not well enough known, or focused upon"* (R6,RAC).

4.4.3 Feared magnitude (worst-case scenarios)

In this part feared magnitude of a major accident while utilising integrated operations (IO), are presented. Feared magnitude will denote worst possible consequences of a major accident. The following opinions were expressed:

A consultant believed worst-case scenarios of major accidents using IO would entail solely environmental aspects. He reasoned that since IO reduce the number of personnel offshore the severity of major accidents will be greater with regard to the environment and the rig itself. A researcher was unsure as to whether the use of IO will enhance or reduce the occurrence of major accidents, but he assumed the consequences would diminish, as less offshore personnel will be exposed to hazards. Seven interviewees (four industry members, two supervisors and one consultant) believed the magnitude of major accidents will stay the same and not change due to IO. All seven referred to installations, personnel and finance as the three main losses of major accidents. One of the supervisors elaborated:

> *"The worst consequence is of course a lot of casualties. I do not fear anything new, beyond what we know of today, such as collision with huge vessels, deliberate actions by on-/ offshore personnel, or terror threat. Other than that it is the traditional major accident such as construction failure, installation collapse, major gas or oil spillage that may cause explosions and of course environmental destruction"* (R11, supervisor).

Four interviewees (two researchers, one supervisor and one consultant) found it impossible to comment upon this question. However, the consultant mentioned that in theory, the potential for major accidents could decrease as IO would improve the monitoring influencing factors.

4.4.4 Increased demands on information and communication technology

With regard to increased demand on information and communication technology (ICT) by IO and the risk of major accidents, the participants stated positive, negative, neutral and sometimes complex outlooks.

Three of the supervisors believed the increased demands on ICT by IO to be positive, and not impose the risk of major accidents. One of them mentioned that ICT demands could create a more complex system for personnel in charge of the infrastructure, but claimed that firm system security levels and system uptime would be easy to uphold. Another supervisor claimed that the demands on ICT had always been present, and the only thing that had changed was people's awareness of it. Moreover, she acknowledged it might be challenging to preserve personnel's awareness of ICT, as it becomes the central element of the sector to a much greater extent than before IO. The third supervisor viewed ICT as very important in developing strict industrial requirements that the entire business can agree upon. She believed mutual standards and requirements between operators, suppliers and authorities may enhance cooperation. Additionally, rules and regulations need to be adapted, to fit the challenges and possibilities that IO might inflict. Two interviewees (one researcher and one consultant) expressed multifaceted attitudes. The consultant claimed that on the one hand technical reliable systems had several positive aspects as they would contain all necessary information. However, on the other hand, he was worried about the systems influence the on petroleum personnel. The researcher stated the following:

> *"It consists of both positive and negative aspects. On the one hand you have a better data foundation, better overview and monitors, which decrease the risk. Then, on the other hand you become more dependent on systems that can be vulnerable with regard to terrorism, sabotage or other stuff"* (R13, researcher).

Apprehensions with regard to increased risk of system halt[26] and hackers were highlighted by some of the interviewees. A researcher stated that he was afraid it would become easier to find errors within ICT systems. Continuously, he feared this might result in an enhanced risk of someone managing to break in and do damage and create major accidents. An industry member drew attention to information security aspects when he claimed the following:

> *"The media portrays risk aspects of major accidents with regard to relocation of work tasks and confusion regarding who does what as the biggest hazards, but I do not believe the hazards are there at all. I believe that errors in connection to information security will occur when different programs are connected. I actually believe this is the main challenge with integrated operations and major accidents"* (R5, industry).

[26] System halt is the rare case when a system encounters a non-recoverable error and the only recourse is to halt the system (Microsoft, 2010).

A consultant claimed that a connection between the two subject areas in question were lacking, and stressed that if an operation loses ICT it depends on in order to be carried out, one will have redundancy in shutting down the operation. However, five other respondents (three industry members, one researcher and one consultant) viewed ICT dependability of IO as a severe threat causing major accidents. Two of the industry members specified what kind on ICT dependability they had in mind. One of them drew attention to fibre optic cables:

> *"I believe fibre optic fall out will have severe consequences today because it has become more complex and difficult to pursue. It is easy to imagine how an error made in one place can have really large consequences somewhere else"* (R7, industry).

The other industry member mentioned bandwidth capacity and speed:

> *"I believe the bandwidth is a challenge because in some waters nothing other than satellites will function, and they have limitations. So that is a limitation of IO"* (R8, industry).

4.4.5 Will disaster strike?

The last part is concerned with the respondents' opinions on the prospect of major accidents happening within the first ten years of utilising IO. Six interviewees (two industry members, one researcher, two supervisors and one consultant) responded rather modestly and claimed they were unable to provide an answer. One of the researchers stated the following:

> *"I am in no position to say anything about that because I do not know anything about these details"* (R3, researcher).

Four of the other respondents (two researchers, one supervisor and one consultant) found the probability of major accidents occurring, after the implementation of IO is completed, to be very small. One of the researchers claimed that the probability of major accidents happening will not increase because IO are implemented. Equally, the consultant stated that nothing will happen during the first ten years. However, by looking across a thousand or ten thousand years, then maybe something would happen. The supervisor believed the probability would be less than 10 minus 4 (i.e. one in 10,000). The remaining three industry members saw the probability of major accidents as decreasing when IO are fully implemented. One of them said:

> *"I do not think it will become worse, rather the opposite. Integrated operations are being implemented in order to improve the industry and reduce the probability of major accidents happening. If there were the slightest belief that it could go the other way we would never do it"* (R8, industry).

4.5 Risk management and integrated operations

In this subsection the following three areas are mapped out: a) the respondents' beliefs regarding the requirement of an information and communication technology (ICT) specific defined situations of hazards and accidents (DSHA); b) what challenges the actors believe IO may impose on the industry in relation to risk management; c) suggestions on what can be done to improve risk management following IO implementation.

4.5.1 ICT-specific DSHA

Risk management within the petroleum sector has a proactive focus that revolves around barriers and barriers thinking. With the implementation of IO questions regarding the necessity of developing ICT-specific DSHA have arisen. Generally, the participants' opinions on this subject matter consisted of pros, cons and uncertainties.

Eight interviewees (two industry members, two researchers, four supervisors, and one consultant) believed that creating ICT-specific DSHA would be a positive contribution to the industry's existing barriers. One of the supervisors stated:

> *"If you want to be in control you need to know about hazards and you need to prepare for them. Developing ICT-specific DSHA is something I believe will benefit these objectives, and during the process you will manage to identify new critical areas. A process that identifies hazard elements is important and a DSHA may be such a process"* (R2, supervisor).

All eight respondents mentioned the sectors increasing dependency on ICT as the main reason for needing to develop ICT-specific DSHA. One of the industry members stressed:

> *"What used to be 'nice to have' is today a 'must have', such as bandwidth and connection between sea and shore via computers. They are vital in order to get updates"* (R8, industry).

One of the supervisors argued that petroleum companies rarely reported ICT incidents before, but since the implementation of IO started more and more ICT reports has been filed. Additionally, she thought several oil and gas companies have started to shape ICT-specific DSHA, with the intention of creating better tools for readiness analysis, and implement them into ordinary training and incident thinking. One of the industry members elaborated how ICT-specific DSHA probably would be very relevant and useful with regard to today's readiness aspects of IO, since remote operations enhance the interfaces among offshore and onshore sites. Nevertheless, she claimed that she would rather see ICT aspects incorporated into pre-excising DSHA than new ones being developed. One of the other consultants believed there will be no need for ICT-specific DSHA, without offering any specific explanation as to why. Similar notions were expressed by two other interviewees (one consultant and one industry member). They portrayed ICT broadness which covers aspects such as rupture of fibre optic cables, viruses, alarm stop, and system loss, the explanation for their beliefs. Subsequently, they assumed that ICT-specific DSHA would be nearly impossible to produce. The consultant elaborated:

> *"It is situation dependent. Whether it is in relation to the use of videoconferencing equipment or running a control room are two different situations. If DSHA are needed they have to be much more specific about what they embrace than just ICT"* (R1, RAC).

Three other interviewees (one industry member, one researcher and one consultant) were uncertain about the subject in question. The industry member thought developing ICT specific DSHA sounded logical as IO incorporate new technology that enhances organisational complexity

4.5.2 Challenges of risk management due to IO

On the subject of risk management and IO all of the respondents mentioned challenges in relation to man, technology or organisation (MTO). A supervisor mentioned cross-disciplinary communication as a risk management challenge of IO. He stated that by using IO disciplines that seldom communicate, such as ICT and automation, will need to be in continuous dialogue. Consequently, they will find a common way of communicating to maintain a good risk management process. Two respondents (one industry member and one consultant) mentioned the introduction of new subjects and work processes as a risk management challenge in relation to how risk analysts might face unfamiliar settings they have no prior knowledge of. One of the supervisors drew attention to aspects of remote operations as risk management challenges, such as competence and knowledge about the rig, equipment and colleagues. Moreover, a researcher pointed out how increased system complexity might become a risk management challenge of IO as it influences employees' use of new risk analysis or maintenance staff training. Equally, one industry member found the designing of risk analysis and tool developing, suited for different operator phases, to be risk management challenges of IO.

Some of the stated risk management challenges were related to human interaction, which is difficult to identify, yet essential in order to maintain a good organisational setting. For instance a consultant claimed interrelated human aspects to be the biggest area of concern, and not ICT aspects like system reliability and availability which the industry focuses on. One of the supervisors believed making sure employees' risk understanding is adequate is a risk management challenge. A researcher stated the following challenge:

> *"It is mostly that one has to think in new and unfamiliar ways"…."You need to reset your way of thinking within some areas. Perhaps even be aware that new problems, that one hasn't considered might yet arise"* (R13, researcher).

In contrast to the previously mentioned risk management challenges, related to MTO, some respondents had other opinions. An industry member explained how the implementation of IO was, to him, just the same as any other new project related to change. He said:

> *"I think about IO the same way as any alteration projects within an oil company. They should be managed in the same manner. It is not a special issue"* (R5, industry).

Two other interviewees (one researcher and one consultant) stated that IO would not create any risk management challenges. The researcher said that the introduction of IO would require some new systems. Furthermore, to get the same surveillance barriers as before IO will require thorough analysis in advance. However, he saw no reason to be concerned about anything going wrong and thus creating new risk management challenges. According to the consultant there will be no risk management challenges as IO enable the industry to manage risk better, since barriers will become more visible, available and easier to control.

4.5.3 Improvement suggestions on risk management following IO

Several of the researchers claimed they had no risk management propositions, but one industry member expressed a hoped that IO would enable the industry to see trends earlier, in order to act upon them. A consultant suggested that increased attention, more formalised structure and formal meeting areas might improve the risk management of IO. He elaborated:

> *"I think one has not thought enough about IO as an issue yet, so that needs to be the first step. One has to get people to realise that these things influence risk. It can be managed by getting a more formalised structure and formal meeting areas. The familiar stuff needs to be replaced by something that is just as good"* (R1, RAC).

Equally, one of the researchers suggested that increased awareness among personnel might improve risk management. Three other respondents (one industry member, one supervisor and one consultant) mentioned how cross-disciplinary communication and sharing of experiences might improve risk management. Additionally, the consultant suggested that cross-disciplinary sharing of knowledge should be incorporated in DSHA readiness planning. The two others made these suggestions:

> *”Different disciplines have to talk more and share experiences, for instance between suppliers and operators. The dependability elements need to be acknowledged and one might have to find new ways in which to work together that enables one to know what others are doing”* (R2, supervisor).

> *”I believe a closer dialogue between shore, sea and sub-suppliers could help us identify the problem areas, be closer and more hands on”* (R8, industry).

Two industry members suggested that the best way to improve risk management would be to develop tools and methods that acknowledge the importance of human and organisational aspects. The industry member stated:

> *“One needs to develop tools and methods that measure the quality of soft safety barriers to get a better organisational understanding about the fact that technological aspects are not necessarily the only concern any more”* (R7, industry).

A supervisor mentioned that she would have liked to see the supervisors become more visible with regard to discipline follow-ups just as the work in other supervision sectors are conducted. Another supervisor claimed that the most efficient way to manage risk would be to know what you want with IO in advance; to have a solid plan that identifies what it is one seeks to achieve with IO.

With regard to whether risk management related to IO is being adequately managed, five respondents (two industry members, one researcher, one supervisor and one consultant) claimed they were not sure. Four other respondents (one industry member, one supervisor and two consultants) said it was not. They all believed more could be done with regard to unforeseen obstacles and ways to improve barrier indicators. The supervisor elaborated:

> *”I believe more can be done, and that we have a job to do in relation to the overall picture. We see examples of this with regard to drilling and well, that more and more equipment is becoming web based, both from the seabed and up on the installation, which may constitute a challenge. I don’t think enough is being done there”* (R12, supervisor).

Another supervisor expressed scepticism and stated that it would be dependent on which industrial sub-cultures one had in mind. An industry member believed enough is being done. However, he was not sure how efficient it all was. He elaborated:

> *“Many rules that have to be obeyed are developed for specific situations that are not necessarily relevant any more. Therefore, one keeps doing unnecessary risk analysis sometimes”* (R7, industry).

4.6 Summary of the main findings

How do actors from different expert groups perceive risk and risk management in relation to petroleum production in an integrated operations environment?

In general, the research findings imply that risk is perceived differently and independently of the distribution across expert groups. Moreover, the most important finding in relation to *experts' knowledge about integrated operations* revealed that the 13 respondents hold varying IO knowledge, within and across expert groups. The research findings also indicate that possibilities and expectations of IO can be associated with areas like finance, HSE, surveillance, operations, cooperation, expertise and decision-making. The key findings concerning *definitions of risk* imply that the respondents have a common risk definition, from the engineering science of expected value (EV).

The main finding with regard to *hazards and vulnerabilities of integrated operations* indicates that in the interface between man and technology various risks might occur. Risk related to aspects such as human characteristics, management, decision-making, knowledge and competence, communication and cooperation, dependence, system complexity and security. The primary finding in relation to *major accidents and integrated operations* is that interviewees hold varying beliefs regarding whether or not there is a link between the two factors. Moreover, the risk of major accidents is mainly believed to diminish with IO but should it occur, consequences are believed to similar as to prior major accidents. The findings also revealed several important concerns, including apprehensions regarding how the causes of major accidents are not thoroughly know among personnel, and that ICT complexity might bring about the risk of sever security problems.

The main finding for *risk management and integrated operations* denotes that factors in relation to man, technology and organisation are challenges that need to be acknowledged in order to bring about improvements. Additionally, the findings indicate that ICT-specific DSHA following IO are considered useful, and uncertainty towards if enough is being done to manage risk following IO flourish. In that respect, numerous risk management suggestions were stated like sharing of knowledge and experience, tool creation, enhancing the focus on interfaces between human and organization, as well as encourage supervisors to become more visible.

5. Discussion

The main contribution of the research findings is detailed information about how 13 actors in relation to the petroleum sector at the Norwegian Continental Shelf (NCS) perceive risk and risk management. However, there is a question whether the results are adequate and of sufficient quality to answer the research question? In order to find out, methodological reflection, central aspects and new areas of concern need to be considered. At the end of this section, implications for further research and an overall conclusion will be stated.

5.1 Methodological reflections

Three central methodological aspects need to be discussed in order to say anything about the quality of the findings.

Credibility: are the research findings credible? Since the concept of credibility in a qualitative study refers to how trustworthy the conducted research is (Thagaard, 2003) aspects that could influence the concept need to be considered. One aspect that might have influenced the findings credibility is the use of three different interview settings. According to Rapley (2007), the use of ICT equipment like videoconference and telephone can limit the collection of data material. However, various interview settings had to be used in this research study. Moreover, as the results *can*, not *will*, be limited by this factor, the influence is not certain. Another aspect that needs to be considered with regard to credibility is the challenge of portraying the respondents' statements correctly when translating from Norwegian to English. It needs to be recognised that limitations unknown to the researcher might have influenced the results credibility as translations from collected data constitute a challenge for the researcher (Trochim, 2001). However, as it is not certain that the finding has been influenced, and the translation is done to the best of the researchers' ability, essential information is believed preserved. Furthermore, as the findings originate from a qualitative study, which is based on the respondents' subjective understandings of the world, it might entail errors. Yet, Thagaard (2003) emphasises that it is always possible to come across biased sources and errors in scientific studies, since there is no way of knowing where the respondents' expertise ends. Therefore, the main focus throughout this thesis has been to trust the respondents and believe that what they say actually is their individual perception of risk and risk management. Even if the respondents' perception contain errors people's understanding of risk is the foundation they tend to act upon (Slovic 1992a). Therefore the respondents' statements are believed to contain information of the utmost importance to the research question. Overall, the research findings of this study are believed to be credible.

Confirmability: to what extent are the findings confirmable? The methodological aspect confirmability refers to the researcher's ability to be critical of their own interpretations as well as the supporting evidence from similar research (Trochim, 2001). Both areas need to be discussed in relation to this study. Due to the research area's novelty no similar studies exist on IO and risk perception. As a result, comparisons with previous findings are not possible. Even though comparable research findings are missing, the theoretical framework of this thesis is founded upon solid findings from psychological research as well as industrial reports and studies of integrated operations. The theoretical framework was selected with the intention of creating a solid setting for interpreting research findings that might contribute to enhance the finding's confirmability. Additionally, all methodological choices and aspects of the research study were thoroughly outlined in an effort to keeping a close eye on the development. Mapping out every decision has provided a solid foundation in order to critically assess interpretations. Actions like this may, according to Trochim (2001), strengthen a research study's confirmability. Overall, the research findings are considered confirmable.

Transferability: to what extent are the research findings transferable? Since transferability refers to whether interpretations developed for a specific research project can be relevant in another setting (Thagaard, 2003) central elements of this study need to be assessed. To begin with sampling should be evaluated. The fact that personnel from the RIO-project helped assemble respondents could, on the one hand, be a positive contribution with regard to familiarity and knowledge of the sector's IO development. On the other hand, the manner in which the respondents were chosen might have biased the results as the RIO-project's personnel could have contributed to assembling a specific kind of respondent. If so, respondents selected independently could differ from those in this study, and potentially create other findings. Furthermore, the total number of respondents in general, as well as across the four expert groups, is relatively low compared with the total number of people in both the sector and the four expert groups. Since it is impossible to know who has been left out and what their expertise is, another set of respondents might bring about different results.

Next, the quality of the four experts groups should be considered. The fact that each of the expert groups covers essential areas of the petroleum sector at the NCS, as well as in relation to other oil producing countries, they are seen as a positive contribution. Continuously, selecting respondents from various expert groups contributes to capturing the complexity of IO in their line of work, such as varying knowledge and expertise. As a result, it can further be argued that the expert groups provide meaning beyond the setting of this particular study. However, the division of respondents across expert groups may also limit the results as there are so few respondents within each expert group. Hence, it is impossible to know if the findings of this study correspond with the given expert groups' typical way of thinking. Overall, central elements likely to have influenced this research study make it impossible to say anything about the results transferability. Therefore, the findings are considered sufficient in order to say anything about the 13 respondents of this study, but insufficient in order to say anything about the entire sector.

5.2 Central aspects and new areas of concern

Methodologically, the findings are of sufficient quality, although they only provide information about the specific respondents of this study. To find out if the results are sufficient to answer the research question the implications of the central aspects of the study need to be considered.

To begin with, the fact that the findings portray similar IO elements as hazardous and holding possibilities imply that IO comprise risks (section 1.4 definition of risk). For instance, the findings mentioned that the industry is dependent on a development within ICT in terms of growth, which might also create increased system complexity and security issues (section 4.1.2 and 4.3). However, the positive and negative statements of IO are compatible with the expected consequences of IO outlined in the theoretical framework (OLF, 2006b; GEMINI, 2009). Moreover, the findings indicate that use of the traditional risk definition of EV (table 3) is a common perception among the respondents. Even though the results are considered too inadequate to be applied to the entire sector, the theoretical framework is not. According to the theory (section 2.2.1) the traditional EV definition tends to be the overall notion within the sector. However, one can speculate whether this traditional definition will be sufficient to analyse the interfaces between generation 1 and generation 2 as new and more complex systems are introduced by IO. In accordance with the theoretical framework, the findings indicate that increased system complexity and industrial challenges in relation to MTO aspects will occur due to IO. Additionally, several of the implied hazards/vulnerabilities that the industry might have to face (see table 4), are expected with regard to the transitions of generation 1 and generation2. Seeing that the transition between generation 1 and generation 2 is believed to surface shortly, even though of the time frame of IO is somewhat delayed (figure 1), and that IO are expected to increase the complexity of the interfaces between MTO (section 2.4.2) the suggested hazards and risk management suggestions (section 4.5.2) may be of utmost importance in order to improve and strengthen risk management of IO.

Nevertheless, even though the research findings might provide useful information about current beliefs, it is difficult to know exactly how IO will function in the future. Perceptions of IO tend to be derived from knowledge about the present system (section 2.1). However, is this knowledge sufficient in order to understand how the work process will function in the future? Considering the fact that the implementation of IO has begun the petroleum sector must believe the answer to the question is yes. If IO are to become a success, the current knowledge, ideas and reports need to be correct and functional. Nevertheless, the results imply that IO are also doubted, as explicit uncertainty was expressed, and indicated that negative psychological effects such as increased or altered risk perception (table 4), might arise due to IO. For instance, findings reveal concerns that IO happens too quickly and that the purpose of them has not yet been given sufficient attention. What might be the reason for this doubt? The fact that no common definition of IO exists (Tveiten *et al.*, 2009) could be one reason, as it makes it difficult to conceptualise exactly what IO are and what they constitute. Furthermore, the prospect of encountering company dependent terminology and different versions of IO (section 2.1.1) might add even more confusion. Overall, as the processes of implementing IO occurs at an uneven pace across petroleum companies it is not surprising that the respondents perceive IO as chaotic or disorganised, and thus feel uncertainty with regard to the implementation and meaning of IO. However, there could be other reasons for the respondents concerns about IO. According to Perez-Floriano *et al.* (2007), trust can be an influential factor with regard to risk perception. Therefore, doubts concerning whether IO are really safe and have been thoroughly explored may explain why the respondents see the risk of IO as so sever. Another explanation could be the perceived seriousness of the risk (Renn, 2008). The respondents may be affected or exposed to risk of IO to varying extents, and thus perceive hazards/vulnerabilities of IO as more serious than they are.

The findings further indicate that saying anything about the known or unknown risk aspects of IO would only be possible in retrospect, not in advance. These results are alarming and confusing, as it tends to be customary for those involved in and affected by the changes of a project to have an idea about potential risk aspects prior to implementation. With regard to a project with characteristics like IO, it seems especially strange that everybody concerned does not know information of this kind. Even if the respondents' concerns are illegitimate, the findings still imply that there is a need for increased information distribution about IO and its purpose within the sector. What if, however, the respondents' concerns are legitimate? It seems unlikely that huge projects like IO have been initiated without thorough knowledge about what they will lead to. Tveiten et al. (2009) emphasise that some IO knowledge has to be gained through practical experience and assessments made throughout individual companies. One can further speculate about how much trial and error will be allowed and how responsible this is.

According to the PSA no overall IO-regulations exist and the responsibility for IO therefore rests upon individual companies (section 5.2.5). Perez-Floriano *et al.* (2007) emphasise that in addition, the government and the company's federation tend to be responsible for managing risk in companies and organisations. If this applies to the implementation and utilization of IO in the petroleum industry, it could mean that the different companies do not necessarily have full responsibility. But are the different players within the sector aware of their areas of responsibility with regard to IO? The prospect of them knowing is relatively large as the PSA are in change of making sure they do, and the findings imply that rules and regulations need to be adapted in order to fit the challenges and possibilities that IO might impose on the industry. However, even though the results imply that use of IO are believed to cause vast changes that affect the entire sector, the different aspects of responsibility have been given surprisingly little attention by the respondents. One can only speculate as to why, but maybe the confusion and uncertainty surrounding the concept functions as a distraction.

Another central aspect is how the findings indicate a decrease in risk when IO are introduced because less people will be present on the platforms. This was portrayed as a major argument with regard to a reduction in the number of major accidents. This belief is in accordance with a lot of the outlined theoretical foundation (section 2.1.3). But are less people exposed to danger equivalent with a reduced risk? On the one hand, remote operations will reduce the number of offshore personnel meaning less people are exposed to hazards as fewer people are needed on oilrigs (OLF, 2006a; OLF, 2006b; OLF, 2008). Equally, the engineering definition of risk, which is the one employed by most of the respondents of this study, uses statistical estimations that consider risk on the basis of the number of casualties (Crossland *et al.*, 1992). Therefore it could be possible to argue that less people exposed to danger is equivalent with risk reduction. On the other hand, it is possible to draw attention to how remote operations reduction of offshore personnel fails to mention anything about the conditions for those left on the rig. If the risk to the remaining personnel decreases, it is still possible to argue that less people exposed to danger is equivalent with risk reduction. However, if IO increases the risk to a reduced number of offshore personnel, one can argue that fewer people exposed to danger is not necessarily equivalent to risk reduction.

The findings indicate that the consequences of major accidents following IO will stay unchanged, apart from with regard to the preceding belief that is also put forward as main argument for consequence reduction of major accidents. This fact raises speculations if the risk image in relation to IO might be too limited? According to the definition of a major accident (section 1.4) environmental effects are just as important as human lives. Moreover, consequences and risk reduction in relation to major accidents focuses on damage to/loss of human lives, serious environmental damage and loss of financial assets (PSA, 2010e). Therefore, it seems peculiar that the findings draw minimum attention to environmental risk and one can only speculate in if the findings would have been different had the interviews been conducted following the Deepwater Horizon accident. If reducing/eliminating the number of people on the platform decrease the risk of environmental damage or loss of financial assets, one can argue that less people exposed to danger can be equivalent with risk reduction of major accidents. However, if the risk to environmental damage, loss of financial assets or the personnel left on the platform increases, one can argue that less people exposed to danger is not equivalent with risk reduction of major accidents. A main argument for initiating the implementation of IO has been the beneficial effect it would have on risk in relation to HSE aspects (section 2.1.3). Perhaps one also believed the risk of major accidents would decline. The findings indicate that the risk of this type of accidents happening is believed to decrease following the implementation of IO. However, the preventative efforts by remote operations through the control room centre in Huston, Texas, could not prevent the Deepwater Horizon accident still occurred. Due to e-drillings vast resemblance to IO at the NCS, one can speculate in weather IO will contribute to ease the concern of risk in relation to activity at the oil rigs.

5.3 Implications for further research

In view of the fact that no similar study has been conducted it would be interesting to repeat the study with both new and more respondents. Although a more extensive qualitative interview study would be able to draw more certain conclusion it would be very time consuming. Therefore, one suggestion for further research could be to develop wide-ranging studies using questionnaires. This way more respondents would be attainable and specific selected areas could be investigated in-depth. Some of the central findings from this research study could, for instance, be developed further to create a questionnaire that specifically focuses on hazards in relation MTO and IO. By using quantitative measures a more detailed picture of petroleum personnel's risk perception of IO at the NCS could be mapped out. As the four expert groups cover the main branches of the sector preserving them for further research might be prudent; one could choose to focus on one or all of the four expert groups. Additionally, including operators would be interesting as they are missing from this study, and are those, mainly exposed to risk in relation to petroleum production

5.4 Overall conclusion

The main contribution of these research findings is their ability to map out how a few actors in the petroleum sector perceive risk and risk management in relation to IO. Great individual differences were revealed, both within and across expert groups. Furthermore, the notion that risk aspects in relation to IO are perceived most hazardous with regard to advanced generation 2 development like remote operation and relocation of personnel, might be of major importance as the transition from generation 1 to generation 2 is progressing.

Moreover, the results are believed to be of relevance for future resilience[27] in the sector, as numerous risk management suggestions with regard to hazards/vulnerabilities of IO were mapped out. These included the likely increase in the complexity of interfaces between man, technology and organisation (MTO) and profound risk management challenges of IO, which may provide guidance with regard to the development of efficient and resistant tools for risk reduction and hazard identification. Additionally, the positive outlooks of IO through

[27] Resilience is the ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (UNISDR, 2009, p. 10).

expectations and possibilities provide a solid foundation for further work as it reveal a glimpse of current awareness across the sector.

Overall, IO seem like a somewhat diffuse and immature area as companies are allowed to include whatever they want in them, and a lot of different expertise is needed to make them work. Currently one tries to get an overview of IO altering processes and their development. However, IO have not yet differentiated with regard to technical computer transfer or fundamental construction demands. As a result these areas are still being explored, altered and escalated. As the research findings indicate, there is confusion with regard to what IO are. Continuing expansion could benefit by creating a more explicit definition of IO so that the concept becomes clearer. Alternatively, one could eliminate the concept of IO and use the numerous company specific terminologies that flourish instead.

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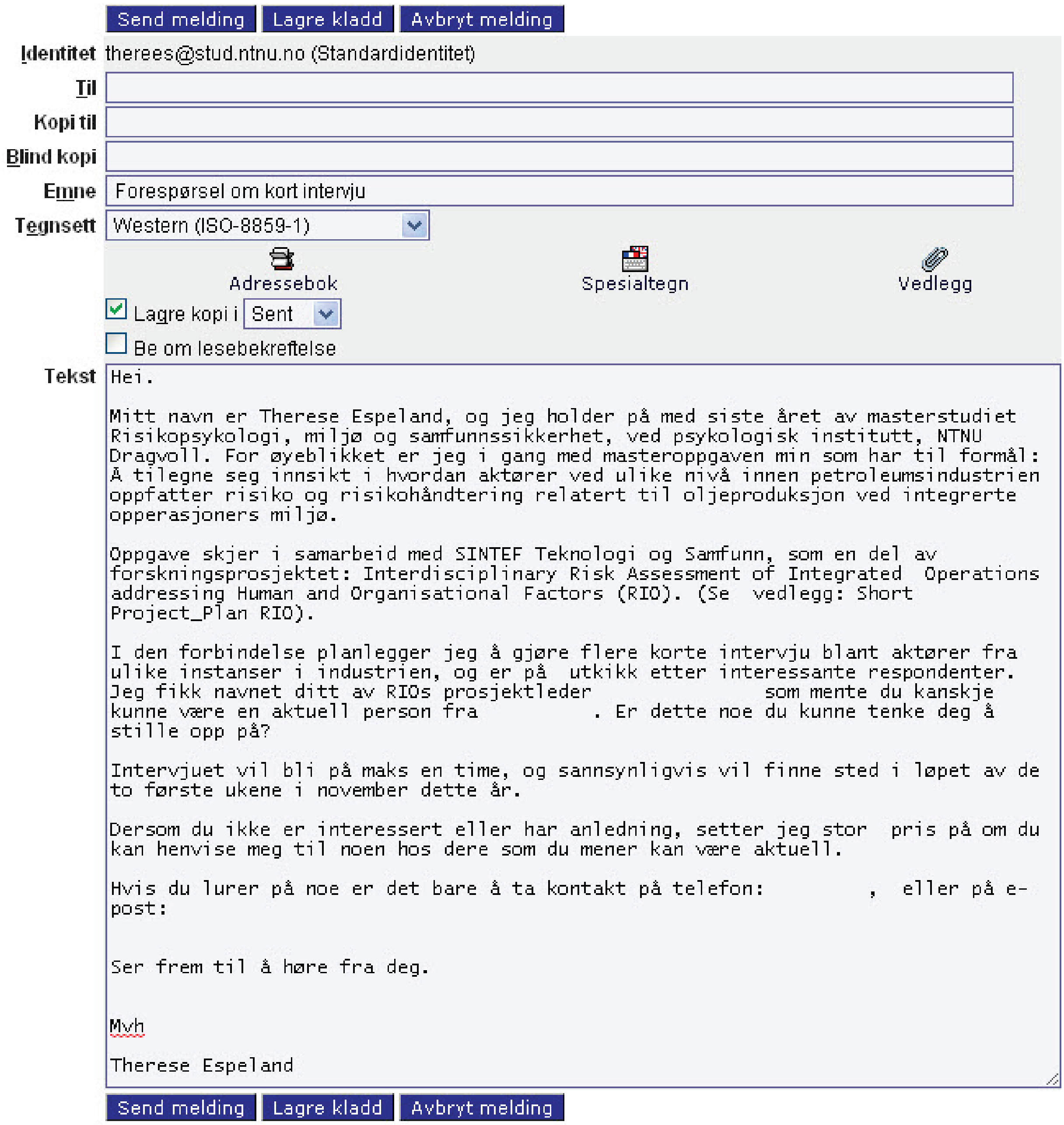
Appendix 1

This is the e-mail that was sent to potential respondents, requesting participation in the research study.



Send melding | Lagre kladd | Avbryt melding

Identitet thereese@stud.ntnu.no (Standardidentitet)

Til

Kopi til

Blind kopi

Emne Forespørsel om kort intervju

Tegnsett Western (ISO-8859-1)

Adressebok Spesialtegn Vedlegg

Lagre kopi i Sent

Be om lesebekreftelse

Tekst

Hei.

Mitt navn er Therese Espeland, og jeg holder på med siste året av masterstudiet Risikopsykologi, miljø og samfunnssikkerhet, ved psykologisk institutt, NTNU Dragvoll. For øyeblikket er jeg i gang med masteroppgaven min som har til formål: Å tilegne seg innsikt i hvordan aktører ved ulike nivå innen petroleumsindustrien oppfatter risiko og risikohåndtering relatert til oljeproduksjon ved integrerte opperasjoners miljø.

Oppgave skjer i samarbeid med SINTEF Teknologi og Samfunn, som en del av forskningsprosjektet: Interdisciplinary Risk Assessment of Integrated Operations addressing Human and Organisational Factors (RIO). (Se vedlegg: Short Project_Plan RIO).

I den forbindelse planlegger jeg å gjøre flere korte intervju blant aktører fra ulike instanser i industrien, og er på utkikk etter interessante respondenter. Jeg fikk navnet ditt av RIOs prosjektleder som mente du kanskje kunne være en aktuell person fra . Er dette noe du kunne tenke deg å stille opp på?

Intervjuet vil bli på maks en time, og sannsynligvis vil finne sted i løpet av de to første ukene i november dette år.

Dersom du ikke er interessert eller har anledning, setter jeg stor pris på om du kan henvise meg til noen hos dere som du mener kan være aktuell.

Hvis du lurer på noe er det bare å ta kontakt på telefon: , eller på e-post:

Ser frem til å høre fra deg.

Mvh

Therese Espeland

Send melding | Lagre kladd | Avbryt melding

Appendix 2

This is the declaration of consent that was applied in the research study.

Samtykkeerklæring

Prosjektets formål: Å tilegne seg innsikt i hvordan aktører ved ulike nivå innen petroleumsindustrien oppfatter og håndterer risiko relatert til olje produksjon ved integrerte opperasjoners miljø. Problemstilling: "Hvordan persiperes og håndteres risiko av ulike ekspertgrupper i relasjon til oljeproduksjon ved et miljø av integrerte opperasjoner?"

Undersøkelsen vil resultere i en masteroppgave i Risikopsykologi, Miljø og Samfunnssikkerhet, ved psykologisk institutt, NTNU Dragvoll. Prosjektet skjer i samarbeid med avd. for sikkerhet, SINTEF Teknologi og Samfunn, som en del av forskningsprosjektet "Interdisciplinary Risk Assessment of Integrated Operations addressing Human and Organisational Factors" (RIO). Masteroppgaven vil bli gjort tilgjengelig for prosjektgruppen, rette vedkommende ved NTNU, og kan bli publisert på et senere tidspunkt.

Intervjuer med ansatte ved ulike relevante bedrifter/institusjoner i industrien vil bli utført. Tilnærming til nevnte tema vil foregå gjennom analyse av intervjuer, og sammenlikning med relevant teori.

Intervjuene som blir utført vil kun bli brukt til dette formålet. Det vil bli gjort lydopptak av alle intervjuene. Disse opptakene, samt eventuelle transkriberinger, skal kun være tilgjengelig for Therese Jenssen Espeland, og vil bli destruert etter at masteroppgaven er ferdig. Informantene deltar på frivillig basis og har mulighet til å trekke seg både under og etter intervjuet. Sitater og referanser fra intervjuene kan taes med i oppgaven, men informantene skal anonymiseres slik at ingen samtaler eller utsagn kan spores tilbake til den enkelte.

……………….. ..   ………………..   ……………………………………………………...

Sted   Dato   Signatur Informant

………………….   ………………..   …………………………………………………….

Sted   Dato   Therese Jenssen Espeland

Appendix 3

This is the semi-structured interview guide that was used during the interviews.

INTERVJUGUIDE

Introduksjon:

1) Om RIO-prosjektet:

   Min oppgave skrives i samarbeid med et tverrfaglig/ interdisiplinært prosjekt: "Interdisciplinary Risk Assessment of Integrated Operations addressing Human and Organizational Factors". Prosjektet styres fra avd. for sikkerhet, SINTEF Teknologi og Samfunn, og er finansiert av Norges Forskningsråd.

2) Mitt ærend:

   Masteroppgaven skrives innenfor masterretningen Risikopsykologi, Miljø og Sikkerhet, ved NTNU, Dragvoll, Psykologisk institutt. Oppgavens tema omhandler hvordan risiko oppfattes og håndteres av ulike ekspertgrupper i petroleumsindustrien i relasjon til bruken av integrerte operasjoner. Jeg er spesielt interessert i risiko for storulykker i forhold til IO. Jeg skal snakke med aktører fra ekspertgrupper som risikoanalytikere, konsulenter, myndigheter/tilsyn, industri/næring.

3) Hensikten med intervjuet

   Få innsyn i hvordan aktører fra ulike ekspertgrupper forstår risiko og risikohåndtering i relasjon til bruken av integrerte operasjoner i petroleumsbransjen. I hvilke grad tenker aktørene på samme måte og hvor varierer forståelsen deres? Jeg vil videre spekulere i hva som kan ligge til grunn for de ulike funnene. Jeg kommer til å vurdere, analysere og reflektere over respondentenes svar opp mot aktuell teori på feltene IO- litteratur og risikopsykologi.

Spørsmål:

a) Arbeidsområder

Spm 1: Hvor lenge har du arbeidet ved den bedriften du er ansatt i nå?

Spm 2: Hvor lenge har du jobbet med de arbeidsoppgavene du har nå?

Spm 3: Kan du kort fortelle meg om dine arbeidsoppgaver?

b) Integrerte Operasjoner

Spm 4: Hvilke områder innenfor IO besitter du konkret ekspertise om?

Spm 5: Hvilke muligheter tror du IO vil bringe med seg?

Spm 6: Hva er dine forhåpninger om at IO skal kunne utrette?

c) Risiko

Spm 7: Hvordan vil du definere risiko?

d) Risikopersepsjon av IO

Med utgangspunkt i din IO ekspertise:

Spm 8: Hvilke farer tror du kan oppstå ved bruk av IO i industrien?

- Hvilken fare anser du som størst?

Spm 9: Hvilke former for sårbarhet tror du IO vil kunne føre til?

- Hvilke anser du som mest kritisk?

e) Risikopersepsjon av faren for storulykker ved IO

Spm 10: Hvilke tanker har du om faren for storulykker ved bruk av integrerte operasjoner?

Spm 11: I hvilken grad er faren for storulykker ved IO kjent/ ukjent for industrien?

Spm 12: Hva vil du si er fryktet omfang av en storulykke ved IO?

Spm 13: Hvor stor tror du sannsynligheten er for at en storulykke vil inntreffe innen IO virksomhet i løpet av den førts ti års perioden i drift?

f) Risikopersepsjon av IKT

Spm 14: Hvilke tanker gjør du deg om stadig økende krav til fungerende IKT og faren for storulykker ved IO?

Spm 15: I hvilken grad mener du det er behov for utvikling av egen IKT spesifikk DFU (definert fare og ulykkeshendelse) som følge av implementeringen av IO?

g) Risikohåndtering/ Risikostyring ved bruk av IO

Spm 16: Hvilke utfordringer tror du IO kan bringe med seg for industrien i henhold til risikohåndtreing?

Spm 17: Hva mener du kan gjøres for å forbedre risikostyring som følge av implementering av IO?

- Hvilke spesifikke tiltak tror du kan iverksettes?
- Syns du det blir gjort tilstrekkelig?

Avslutnings spørsmål: Er det noe du vil tilføye?