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Is the Current Management System at Statoil Sufficient to Prevent Potential Major Accidents from Happening at the Snorre A Platform?

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Preface

This master's thesis is a result of the independent work in the Master of Science in Economics and Business Administration education at the Norwegian School of Economics.

The motivation behind this paper was an interest to learn more about change management in the petroleum industry. Working on this thesis has made me more familiar with the various aspects affecting operations in this industry, and realizing the complexity and many challenges prevailing. This work has contributed to extensive learning, and to an increased interest in this field of study.

I am grateful to everyone helping me throughout this process. First, I would like to thank my aunt and uncle in Stavanger, Rannveig Aaland and Jørn Yngve Stokke. Words cannot describe how much I appreciate all the help you have given me. This includes many good conversations, information, as well as letting me stay with you when conducting research in Stavanger.

Furthermore, I would like to thank everyone participated in the interviews. I am very glad, and thankful for all the good information and insight, which have contributed to great research material. This includes interviews, but also access to articles and papers.

I would like to thank my thesis advisor, Professor Bjarne Espedal at the Norwegian School of Economics. Thank you for taking the time to read through my work, and for the good and constructive advices to improve my master's thesis.

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Abstract

Only small margins prevented the gas-blow out at one of Statoil's platforms, Snorre A, to develop into a major accident in 2004. The underlying reasons of the accident showed extensive improvement areas, including Statoil's management system.

The purpose is to find out whether the current management system at Statoil is sufficient to prevent potential major accidents from happening at the Snorre A platform again. As a guidance, four questions have been deduced. These include if Statoil has managed to comply with the requirements imposed by the Petroleum Safety Authority Norway after the accident, which changes have been made in Statoil's management system since 2004. Further, to what extent learning from the Snorre A accident has led to changes in the management system, and if the current management system ensures safety.

In the search of answering the research question, existing theories have served as a tool to get deeper insight into management systems, potential major accidents, learning and subsequent change.

Further, the case study of the Snorre A accident was carried out by interviews. The results were further analyzed, and discussed with secondary sources. The findings shows that Statoil has corrected all the variances found by the PSA. The accident led to many infirmities being detected, and Statoil has employed many resources to improve its management system since 2004. This also include a higher focus on safety and compliance. However, it is found that Statoil lack the ability of sharing knowledge and experience throughout the company, and therefore important qualities of developing a robust organization.

The conclusion suggests that even though Snorre A has become one of the better installations after the accident, and Statoil's management system has improved, any accident can challenge that in the future. Therefore, it becomes difficult to say if the current management system can prevent potential major accidents from happening.

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List of Abbreviations, Acronyms, and Explanations

DPN - *Development and Production Norway (Business Area in Statoil)*

GOV – *Government.no*

HSE – *Health, Safety, and Environment*

IRIS – *International Research Institute of Stavanger*

KPI - *Key Performance Indicator*

MTO - *Man, Technology and Organization*

NTNU – *Norwegian University of Science and Technology*

PSA – *Petroleum Safety Authority Norway*

RESU - *Reservoir and Underground Technologies*

SOX - *The Sarbanes Oxley Act of 2002*

Gullfaks C Accident – *accident at the Gullfaks field in the North Sea, May 19, 2010 (Statoil).*

Macondo Accident – *the Deepwater Horizon accident in the Gulf of Mexico, April 20, 2010 (British Petroleum).*

Snorre A Accident – *accident in the North Sea, November 28, 2004 (Statoil).*

1 Introduction

This chapter presents the master's thesis background, purpose, research question, limitations and structure. The background describes some of the challenges facing the Norwegian petroleum industry, especially relating to potential major accidents. Further, the purpose of the study is presented, with point of departure in the Snorre A blow out in 2004. This potential major accident is discussed in relation to Statoil's management system. What becomes interesting in this matter is to find out whether the current management system at Statoil is sufficient to prevent potential major accidents from happening at the Snorre A platform. Further, limitations of the study and the structure will be presented.

1.1 Background

In the late 1960s, petroleum was found on the Norwegian continental shelf. Since then, the oil and gas activity has altered. Opened areas have become more mature, producing fields are aging, and exploration activity have shown a definite increase. The cost level is substantially higher, and technological developments have improved. Considerably more upstream companies are involved in the activities, and the player scenario has widened (GOV, 2013). In addition, the high speed of globalization lead to companies facing a new era of competition (Davis, 2006).

The petroleum industry is currently characterized by challenging circumstances, and a high degree of complexity. This is seen through the many potential major accidents happening, both internationally, and in Norway each year. The Petroleum Safety Authority Norway (PSA) states that the important major accident indicator is currently moving in the wrong direction. There were no major accidents in Norwegian petroleum-business in 2012, however there were many serious incidents, where many of them had evident potential (PSA, 2013d).

According to the PSA (2013f) a major accident will, in addition to the human aspects, also have substantial consequences for society at large. The reduction of major accident risk is therefore a crucial reason for the formulation of existing health, safety and environment (HSE) regulations. Management has overall responsibility for managing major accident risk,

through initiatives and decisions. Hence, it becomes important for the petroleum companies to find ways to prevent these incidents from happening.

1.2 Purpose of the Study

November 28, 2004, a gas blow-out from well P-31A occurred at Statoil's Snorre A platform in the Tampen area. The Petroleum Safety Authority Norway characterized this incident as one of the most serious accidents to occur on the Norwegian shelf (Brattbakk et. al., 2005). According to findings in the International Research Institute of Stavanger's (2011) report, there were small margins that prevented the incident to develop to a major accident, with loss of lives, and environmental destructions. Serious failures and deficiencies were uncovered in all phases of Statoil's planning and implementation of operations at Snorre A. The PSA appointed an investigation group, which identified non-conformities and improvement areas. These were categorized in four areas;

1. Lack of compliance with governing documents
2. Inadequate understanding and implementation of risk assessments
3. Inadequate management involvement
4. Violation of well barrier requirements

The non-conformities occurred at several levels in the organization, both off- and onshore. The investigation showed that the number of non-conformities and improvement areas were extensive, and could all been intercepted, and corrected if the barriers had functioned. It is common that individual barriers fail from time to time, but an incident where so many barriers in different phases of an operation fail, is extremely rare. The PSA has questioned why these failures were not discovered, and corrected at an earlier point in time.

Both the PSA and Statoil are of the opinion that a good management system is crucial to perform sufficient operator responsibility. The management system must contribute to secure compliance with health, safety, and environmental requirements, which will minimize the numbers of accidents and unwanted incidents (IRIS, 2011).

The purpose of the study is to analyze and discuss if the current management system at Statoil is sufficient to prevent an accident from happening at Snorre A again. Therefore, it becomes

important to find out whether the organization have implemented the requirements from the PSA thoroughly in the management system, and provided sufficient changes to secure safety in all operations. Learning from the Snorre A accident becomes vital in transferring of knowledge and experience. An assumption is made that knowledge and experience can be used as a tool when changing the management system.

1.3 Research Problem

The research problem in this Master's Thesis is;

"Is the current management system at Statoil sufficient to prevent potential major accidents from happening at the Snorre A platform?"

To provide guidance in the search for a solution to the research problem, these questions provide the foundation of this Master's Thesis:

1. Has Statoil managed to comply with the requirements imposed by the Petroleum Safety Authority Norway after the Snorre A accident?
2. What changes have been made in Statoil's management system since 2004?
3. To what extent has learning from the Snorre A accident led to changes in the management system?
4. Does the current management system ensure safety?

1.4 Limitations

This research question *"Is the current management system at Statoil sufficient to prevent potential major accidents from happening at the Snorre A platform?"* is an open ended question, therefore only intended to contribute to an increased understanding of the subject, as well as a supplement to further research. In this matter, it is important to recognize that other aspects than just the management system can prevent potential major accidents from happening. In addition, because of the complexity in this industry, it is difficult to say that the management system alone being either the contributor of accidents happening, or the reason for accidents not happening. This implies that other factors than those mentioned can prevent potential major accidents from happening.

The focus in this thesis will be on prevention of potential major accidents in Statoil's organization. Statoil is the actor, hence by developing the management system, and thereby influencing the safety level both in the system as well as at the Snorre A platform.

The case is about how Statoil has learned from public reactions, as well as own experiences from the Snorre A accident. The thesis is therefore limited by focusing on learning through experience. There can of course be other aspects influencing learning in an organization, which can be an interesting aspect to consider in further research.

1.5 Structure of the Thesis

This master's thesis is divided in eight chapters, including references. In the *first* chapter, the background, purpose of the study, research question and limitations are introduced. The *second* chapter will present theories relevant to solve the master's thesis research question. The theories are used as a foundation for the research methodology, the results and the discussion chapters. In chapter *three*, the research methodology is described in terms of research process, data collection methods and analysis. Reliability and validity will also be evaluated, in addition to limitations. The *fourth* chapter presents the empiric background in this thesis. This includes an introduction of Statoil, the Snorre A organization, and the Petroleum Safety Authority Norway. Also, Statoil's management system, and the underlying causes of the Snorre A accident will be described. The *fifth* chapter presents the results found through collection of primary data. These results will be further discussed with secondary sources in chapter *six*. This discussion makes the foundation for the conclusion drawn in chapter *seven*. Chapter *eight* presents the sources used in this master's thesis.

2 Theoretical Framework

This chapter presents theories that are relevant to solve the master's thesis research question. The theories are used as a foundation for the research methodology, the results and the discussion chapters. The main sections of the theoretical framework have its point of departure in the management system, potential major accidents, learning and change. These theories will help get a better understanding of the various aspects that need to be considered when answering the research question. The management system is an important tool for the organization to implement safe operations. When a potential major accident happen, it will be important to learn from experience, and to change the management system accordingly. The chapter ends with a theoretical summary, including a delimitation of the most important features of theory further used in this thesis.

2.1 The Management System

According to Horngren, et al. (2009) a management system is a means of gathering, and using information to aid and coordinate planning and control decisions throughout an organization. The management system becomes vital to guide the behavior in the organization and should be closely aligned with the company's strategies and goals. This is of particular importance in the petroleum industry, where daily high-risk operations are executed. The management system functions as a framework for safe operations by providing principles and control mechanisms.

2.1.1 The Development of the Management System

Schiefloe and Vikland (2007) argue of a clear development of the management system from a technical age, through the age of human factors, and now the age of management and culture. "The technical age" focused on the technical standard of machines and infrastructure, where safety was considered primarily as a technical challenge. "The age of human factors" have an understanding of technical solutions alone, cannot guarantee sufficient safety, since human behavior and action influence operations. With this basis, the human-machine issues are put to the agenda. Organization of work premises, ergonomics, perception and other factors become central conditions. "The age of management and culture" asserts that management systems,

and organizing are important elements for achieving safety. Some writers emphasize the formal aspects of the organization as structures and regulations, whereas others draw in informal aspects and safety-culture as central variables of explanation.

The age of management and culture is seen as important to many researchers. According to Simons (1995), the management system should be built upon formal and information-based routines and procedures that management use to maintain, or change the direction of the activities in the organization's activities. Merchant and Van der Stede (2007) argue that certain compositions of principles, and other underlying factors such as culture and values, can affect how these function in the organization. The increasing knowledge of the interplay between various elements in the management system is also important to understand the underlying causes of accidents (PSA, 2013a).

Accordingly, it becomes important to understand how the management system is connected, and how the management principles affect each other (Ribe, 2009). A framework much used in the petroleum industry is to build the management system around Man, Technology, and Organization (MTO) (PSA, 2004). This perspective underline that human behavior are connected with, or influenced by, technological and organizational aspects. All these factors need therefore consideration when preparing the management system, and hence improving safety in operations (Schiefloe and Vikland, 2007).

2.1.2 The Pentagon Model as a Framework for the Management System

The operations carried out on platforms are good examples of a field that impose great challenges in the interplay between human, technology, and organization. The driller must have control over the well, lead the work on deck – in addition to use technical advanced, and monitor-based solutions in the drilling department. Because of this, it can be challenging to understand, operate, and keep an overview over all information, in addition to having physical control of what is happening on deck (PSA, 2013a).

The MTO perspective frames the central safety-elements on a higher level. However, it does not say anything about the connections or interface between the elements, and does not give further directions regarding what specific characteristics about man, technology, or the organization to be considered.

Since the management system compose many principles, and even more underlying factors, it is important to get a good overview over the various connections in addition to knowing what the outcome will be if there are any changes implemented in the system (Merchand and Van der Stede, 2007). In this way, MTO needs to be further amplified when used in practice. This applies especially for the factors Man and Organization (Schiefloe and Vikland, 2007). Schiefloe and Vikland (2006) talk about a five dimensional model, the Pentagon Model, which is based on an earlier model by Schiefloe. The five different dimensions are formal structure, culture, interaction and work practices, the state of the informal relations and networks, and technology. This is displayed in Figure 1.

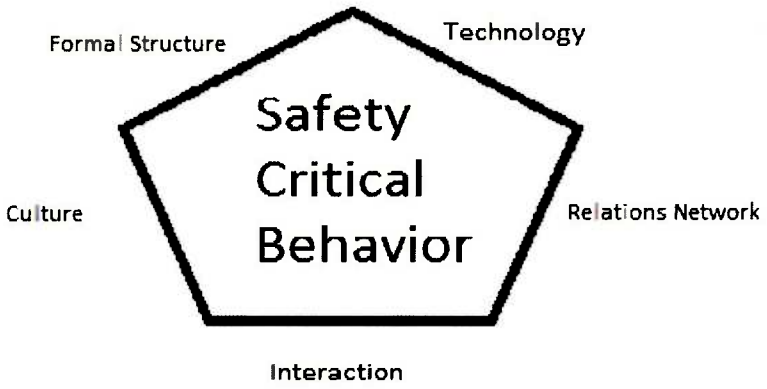

Figure 1: The Pentagon Model
(Schiefloe and Vikland, 2006)

Safety Critical Behavior can be defined as those elements in a work process that directly or indirectly have consequences for whether accidents or unwanted incidents happen, and is understood as being influenced by the organizational attributes in the five dimensional model. Figure 1 illustrates how safety-critical behavior can be analyzed from a constructivist perspective. People are engaged in different activities, interpret situations and tasks they perform, and choose their actions based on their understanding and evaluation of a set of internal and external factors (Schiefloe and Vikland, 2006). The safety level in complex and tightly-coupled organizations are a function of an interaction between human, technological and organizational factors, where the absolute safety level is decided by the weakest link in the chain, and by the barriers of technological or organizational character that can compensate if a link in the chain fails (Schiefloe and Vikland, 2007).

2.1.2.1 Formal Structure

The formal structure is of high relevance at an oil installation. The formal structure creates a framework for the employee's behavior, and thereby safety critical behavior. This is done through governing documentation, sharing of knowledge through different systems, work instructions, and field of responsibility (Schiefloe and Vikland, 2007).

2.1.2.2 Culture

Cultural conditions, such as values, attitudes, working habits, and manners are important explanatory factors when understanding what is happening in an organization. The same applies for histories wandering in the community, and experiences generated by the individual. If stories are told from co-workers about negative reactions from management when raising objectives or critical questions, it can lead to the environment being imprinted with a general restraint with these annotations. Other central topics are what understanding prevails regarding taking chances, and how difficult trade-offs and priorities are handled. Competence is also important, not just on individual level, but on group and system level (Schiefloe and Vikland, 2007).

2.1.2.3 Interaction

Qualities about the interaction is of high significance. Key words are management, communication, teamwork, and work processes. These are important factors in an organization to generate safety critical behavior.

2.1.2.4 Relations Network

In a work situation, the informal aspects of an organization also play an important part. This implies for example the relations existing in the organization between colleagues, leaders, and subordinates affected by friendship, trust or distrust. Informal networks can for example function as a source of information, and exchange of experience. A key concept in this connection is social capital, a collective term for resources that is available, or builds upon informal relations (Bø and Schiefloe, 2007). In accordance with safety, one can also find examples of what is called negative social capital, for example conflicts or mistrust (Schiefloe and Vikland, 2007)

2.1.2.5 Technology

The management system must ensure that technological conditions are under control. On an oil-installation, this is tied to the standard of the equipment, maintenance, routines of working and coordination of operations. The system must ensure that routines are done properly, and that equipment is in perfect condition (Schiefloe and Vikland, 2007).

2.2 Potential Major Accidents and the Management System

Potential major accidents have become a great focus to companies operating in the petroleum industry. This is due to the severe consequences these accidents have both on the environment, on the company, and safety of the people employed. A management system can create a framework for safe operations; however, the question is whether it can prevent potential major accidents from happening.

2.2.1 Potential Major Accidents

In recent years, there have been many potential major accidents in the petroleum industry. A major accident is defined by the PSA (2013f) as an acute incident which immediately, or subsequently, causes several serious injuries and/or loss of human life, serious harm to the environment and/or loss of substantial material assets. By potential means that the incident concerned, under slightly different circumstances, could have developed into a major accident (PSA, 2013e).

Turner (1978), Wachira (1996), Jervis (1997), and Rochlin (1999) (cited in Boin, 2008) claim that we can expect more accidents in the modern environment. These accidents are often transboundary, which appears when the functioning of multiple systems are threatened, characterized by the potential of crossing geographic and functional boundaries. They are affected by the operations and systems in the organization. If the organization are dealing with complex interactions, and hold tightly coupled systems, as in the petroleum industry, unanticipated failures will occur. Tightly coupled systems are characterized by having more time-dependent processes, coordinated sequences, little slack, and hold safety devices which are limited to those that have been planned and designed into the system (Perrow, 1984). Complexity and tight coupling can amplify these chain reactions and lead to increased risk (IRIS, 2011). This means that the operations must be done right the first time, since there is little opportunity to improvise if something goes wrong (Rijpma, 1997).

2.2.2 Major Accidents and Management of Barriers

The PSA have in recent years seen an increasing degree of interaction, and coupling between safety and management systems. There are regulations of sufficient independence between

safety barriers, including requirements of the safety systems being able to carry out intended functions independent of other systems. As a consequence of the technological development, there is an increasing use of integrated systems, including management- and safety systems often delivered by the same producer. Hence, using jointly software- and user interface in different systems, performing integrated operations, having jointly hardware, as well as having an increased signal transmission between systems (PSA, 2010b).

Reason (1997) argues that major accidents normally appear in a combination of active errors of action and latent organizational conditions, which appear in form of weaknesses in the hard and soft safety barriers between the action and the accident. The individual barrier can have many weaknesses or holes. At the best, other barriers will intercept the first barrier's weakness and thereby prevent accidents from happening. This is often mentioned as the Swiss Cheese Model. When all barriers and defense mechanisms fail, the simple incident will transmit in the system and the accident will become a fact (IRIS, 2011).

Questions as to whether it is possible to prevent these accidents, or if they are inevitable are discussed by various theorists. In this matter, this thesis will investigate if a management system can contribute to safe operations, and to prevent potential major accidents from happening.

2.2.3 Organizational Accident Theory

The management system has gotten a completely different focus than earlier, incorporating various aspects of the organization. In this matter, safety is an important keyword, which is a strict focus in offshore activities. Why then are still many potential major accidents happening in the petroleum industry?

There are several viewpoints of whether organizations are able to prevent accidents from happening, or if they are inevitable. A crucial understanding agreed upon is that it takes "just the right combination of circumstances to produce a catastrophe" (Perrow, 1994; Reason, 1990, in Boin 2008). This is a combination of unruly technology and organizational vulnerability (Boin, 2008). Rosness, et al. (2010, cited in Tinmannsvik, et al., 2011) comprise six different perspectives; Normal accident theory, high reliability theory, energy-barrier perspective, information-flow perspective, the goal-conflict perspective, and resilience engineering perspective. Three of these theories will be discussed in this thesis:

2.2.3.1 Normal Accident Theory

Normal accident theory seeks to explain how dangerous technologies can escalate out of control. Theorists supporting this view say that organizations must use structures and process to harness the dangerous potential of powerful technologies. However, the more complex technology and interactions in an organization, the harder it will be for the operators to understand the system. Therefore, organizations will be expected to suffer more breakdowns as society becomes more complex and tightly coupled (Perrow, 1999 cited in Boin, 2008). Even though accidents might be rare, they become a normal result of integral characteristics of the system, and hence inevitable over time (Rijpma, 1997). A management system is therefore needed, but not sufficient to prevent accidents from happening since they are inevitable.

2.2.3.2 High Reliability Theory

This perspective tries to explain how organizations operating high-risk systems avoid accidents from happening. This theory is based on thorough studies of organizations demonstrating a surprising capacity, and ability to handle complex technologies without major accidents happening (LaPorte and Consolini, 1991). Central elements in this perspective are organizational redundancy and the ability of changing operational mode in line with changing demands of capacity (Tinmannsvik, et al., 2011).

High reliability theory assesses that with use of intelligent organizational design and a good management, serious accidents with hazardous technologies can be prevented. The common assumption is not that human beings have the ability of behaving rational, but that a properly designed, and well-managed organization can compensate for human frailties. These organizations hold highly formalized structures, focusing on achieving clear and constant goals (Scott, 1967 cited in Rijpma, 1997).

Within high reliability organization theory, defense mechanisms are divided in two categories, hard and soft (Reason, 1997). Hard defense mechanisms are related to all types of technical arrangements that are supposed to prevent operations from going wrong, and to warn humans about this. Examples are, among other factors, automatic safety systems, warnings, and access codes. Soft defense mechanisms are every organizational initiative, which is meant to reduce risk of unwanted incidents, as regulations, surveillance, routines, procedures and training (IRIS, 2011). The interplay between hard and soft defense mechanisms constitutes the total robustness of the organization, or the technological system. In accordance with the theory,

human action is the main reason why accidents happen, since human beings continuously make risky actions and active mistakes.

2.2.3.3 Resilience Engineering Perspective

The Resilience Engineering perspective is partially made from combining parts of several perspectives, however, is further extended. The traditional approach of safety has clear limitations, since complex organizations are under continuous change. The resilience engineering perspective focuses on organizations being robust. The idea behind the theory is to have the ability to detect and adapt to various situations in the system and the environment without persistent interruptions (Hollnagel, Woods, and Leveson, 2006). Hollnagel (2011) operates with four characteristics to create a robust organization:

1) The ability to react to assumed and unforeseen errors and disturbances

2) The ability to monitor what is going on

3) The ability of foresee possible prospective threats and opportunities,

4) The ability to learn from mistakes and success.

Important fundamental premises for a resilient organization are knowledge, competence, resources, and time (Hollnagel, Woods and Leveson, 2006).

2.2.2.4 Discussion of the Differing Theories

The normal accidents theorists emphasize structural factors of interactive complexity and tight coupling as increasing the probability of accidents, regardless of the intent of management and the management system. In addition, even if there are increased priorities of safety goals, they may be inconsistent and conflicting, which again increase the risk of accidents (Rijpma, 1997).

Because of complex technological systems at platforms, high reliability theorists place great emphasis on the need for redundancy. This involves duplication, and overlap of critical components and personnel to improve safety. Still, normal accidents theorists assert that accidents are inevitable, since more than one component can fail independently at the same time. The Bhopal plant chemical disaster is an example of this; deadly gasses escaped because three separate safety devices all failed simultaneously. Negative consequences of redundancy may be that redundant systems are often less independent than their designers believe, and that redundant backups increase the interactive complexity (Rijpma, 1997).

Today, organizations deal with unexpected dangers in a very rapid fashion. The normal accidents theorists question how a management system will ensure that lower-level personnel will identify situations properly and take appropriate actions in crises. To overcome this problem, high reliability theorists claim that the organizations must recruit, socialize, and train personnel to maintain a strong organizational culture with emphasis on safety and reliability. This constant process is believed to contribute to reduced error rates. According to Roberts, Rousseau and La Porte (cited in Rijpma, 1997) these factors will produce a self-regulating work unit where operators directly address risk, and uncertainties.

The high reliability theorists put faith in organizations dealing with dangerous technology for decades without any major accidents, which is reflected in the safety culture incorporated in the organizations' management system (Boin, 2008). The normal accidents theorists on the other hand, are of the opinion that it will be impossible to make organizations more reliable by importing elements of a safety culture (Weick and Sutcliffe, 2002 cited in Boin, 2008). The increasing presence of technology in modern society harvests the potential for great inadvertent destruction. Therefore, by relying on a safety culture, there will be a concern of leaders becoming listless because of robust design, skilled operators and luck. It might lead to a false optimism, and perhaps complacency about the probability of a catastrophic failure (LaPorte, 1994).

Even though normal accident- and high reliability theory try to explain the underlying factors of an accident, a firmly tested theory does not exist. However, the development of safety critical behavior can be seen as a consequence of increased understanding of the safety-challenges, in addition to an understanding of MTO factors being important. The resilient engineering perspective, which describe that organizations must focus on being robust, is an extended perspective built upon these theories. It is emphasized to establish fundamental characteristics, as reacting to assumed and unforeseen events, to monitor what is going on, to foresee prospective threats and opportunities, and to learn from mistakes and success. To achieve this, the right competence, knowledge, resources and time must be available (Tinmannsvik, et al., 2011). A question becomes whether it is possible to develop these characteristics, and thereby avoid accidents from happening.

2.2.4 Development of Robust Organizations

Hollnagel (2011) suggest that it is possible to develop a robust organization if the company has the ability of quickly responding to unexpected, and expected situations. This is dependent on a balanced interaction between the ability of monitoring what is currently happening, to foresee future developments, and to learn from previous mistakes and successes. These robust characteristics require special competence, and must be incorporated in the management system.

However, the robust characteristics are not always easy to develop. Organizations show evident scarcities of monitoring the current situation, to learn from the past, and at the same time be able to foresee prospective development. Andersen and Albrechtsen (cited in Tinmannsvik, et al., 2011) conclude with some recommendations of improving the organizations ability of adapting to mistakes and interruptions, with a balance between fundamental qualities for robust organizations. This includes, among other factors, to develop the management system and strategies for safety management that ensure balance between compliance of requirements, and the ability of adapting to changes to handle unforeseen and foreseen situations. Further, to improve competence and working situations, and adapt these to uncertain and dynamic outcomes in well and drilling operations. It is important to use proactive process safety indicators to monitor relations that can be dangerous to the safety in the nearest future, to involve all parts of the organization for better support, and improve the systems of information sharing between distributed participants for better decision-support. Finally, they emphasize to handle goal-conflicts between efficiency and safety, and to improve the ability to learn from previous accidents and successes.

To avoid potential major accidents from happening, it is assumed in this thesis that the robust characteristics must be introduced, and incorporated through the management system. This means to include them in the formal structure, in culture, technology, interaction, and relations network. This connection is shown in Figure 2. However, a question becomes whether these robust characteristics are possible to develop, and thereby prevent potential major accidents from happening. Therefore, features of all accident theories will be included when discussing if it is possible to develop a robust organization.

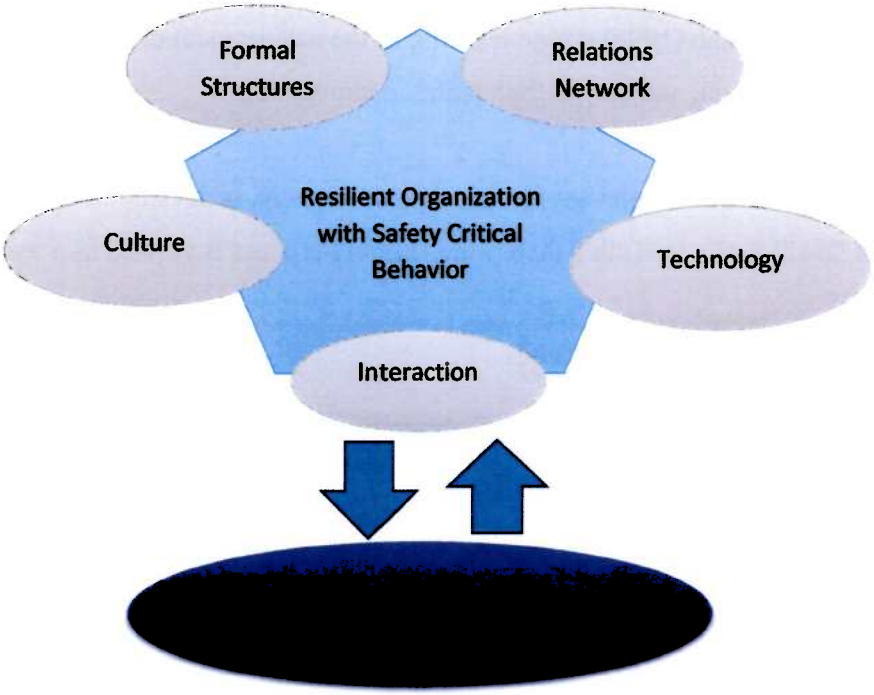

Figure 2: Resilient Organization and the Management System

2.3 Learning and Change after Accidents

When potential major accidents happen, a focus must be on change, and development of the existing management system as a way of securing that they do not happen again. Respectively, underlying causes must be investigated, and initiatives incorporated in the management system. Hence, a focus on learning from previous experience both through own experience, and detected variances by outsiders. When changes are made, it is emphasized that training is important to provide sufficient training to secure that the changes are complied with, which was especially emphasized by the high reliability theorists.

2.3.1 Learning

Learning is an important factor for change and improvement of the management system when a potential major accident has happened. Learning can help improve the management system through the experience obtained, and sharing of knowledge. As Wildavsky (1988) said, *"Without trials there can be no new errors; but without these errors, there is also less new learning."*

2.3.1.1 Learning through Experience

Kaufmann and Kaufmann (1996) define learning as the acquirement of knowledge and skills that is relative permanent, and has its foundation in experience.

A cognitive theory, which is relevant for this type of learning, is developed by the American psychologist David Kolb. In Kolb's theory the learning process is viewed as a cyclic process as in Figure 3:

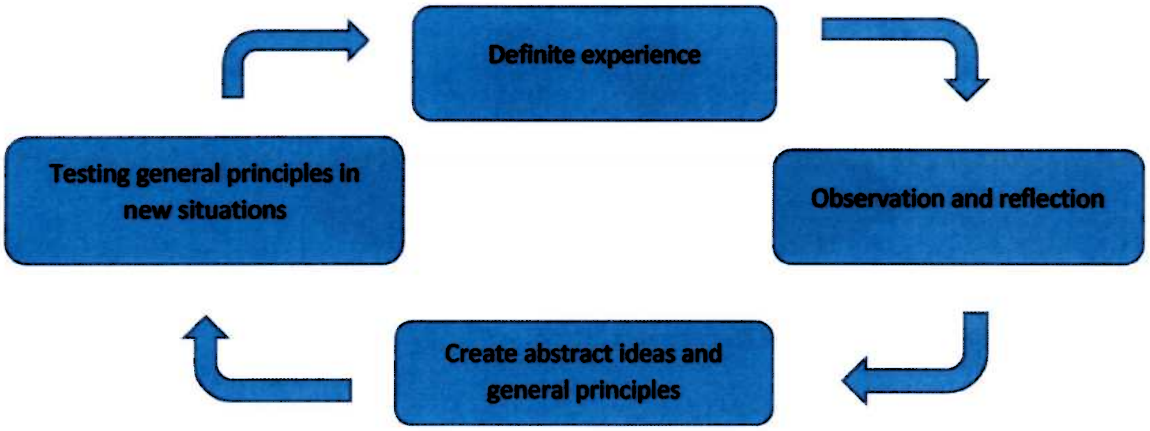

Figure 3: Learning as a Cyclic Process

(Kaufmann and Kaufmann, 1996)

The learning process starts with engaging in a definite experience, as a potential major accident. When an accident happen in an organization, it is possible to observe the situation, and later reflect on possible causes for this passive experience. In this matter, it is focused on observations and experience from the employees in the organization, in addition to third parties observing the situation. Further, it is common to start describing definite experiences in form of abstract concepts and principles. When finding the most relevant concepts, a generalization of the experience with other similar situations that has certain common features is made. The findings from the analysis of the situation become subject of further testing in other related situations. If the hypothesis holds, a better solution to handling problems is established. This implies that transfer of experiences into learning requires the use of experiences to enrich knowledge, in such a way that similar situations can be handled correctly and efficient in the future. However, this does not imply a simple and direct coupling between experience and learning. Psychological research show that learning from experience is often very difficult, and impose many challenges to organizations. The main

reason is because of the practical and pulsating work-life that demonstrates complex, and ambiguous situations (Kaufmann and Kaufmann, 1996).

2.3.2 Development of Systems

To manage change after a potential major accident is not easy. Sirkin, Keenan and Jackson (2005) say that part of the problem lies in people's interpretation of what factors influence transformation initiatives the most. Also, the various reasons for a potential major accident happening. Each person will look at an initiative from their viewpoint, and base the decisions on personal experience.

Argyris and Schøn (in Kaufmann and Kaufmann, 1996) put an emphasis on making a system suitable of correcting mistakes, and solving problems. Focus is directed towards implementing systems and forms of practice, which make the organization a learning organism. Organizations learn, and change on a continuous basis, due to both external and internal sources of stimulation. Further, they claim that much of learning in organizations is characterized as single loop learning. This means that existing procedures, and routines are adjusted by correcting variances and mistakes. Activities within the organization require, however, a great deal of new problem-solving. If the participants question basic principles in how the operations in the company are carried out, and maybe find mistakes and shortages, the process has gone further to a double loop learning.

2.3.2.1 Development of Barriers

Management of barriers becomes important when changing the management system. This includes processes, systems, solutions and initiatives that need to be in place to secure safety through implementation of barriers, hence both hard and soft defense mechanisms. To secure good handling of safety and risk, the involved personnel must have an understanding of why barriers are established (PSA, 2013c).

Recently, investigations of serious incidents, and major accidents in safety-critical industries have put a focus on change processes as a considerable risk-contributor (PSA, 2010a). Also, changes in procedures often involve new elements added to already existing work-process descriptions. This can lead to over-specification and increased complexity, and thereby complicate compliance. The result is an increased gap between defined procedures and

practice (IRIS, 2011). These factors must be considered when changing parts of the management system, since new solutions can establish latent weaknesses (PSA, 2010a).

2.3.2.2 Training

When changes are required, the entire organization must go through sufficient training to ensure that experience, and learning from the accident are understood, and shared through the management system.

A belief that training in use of the management systems is the best way of learning from its mistakes, implies that there is an implicit comprehension of many of the causes to mistakes are staff members incorrect use of the systems. Mistakes lead to lack of compliance of work processes and requirements. Alternatively, one could align the searchlight towards simplification and improvements of procedures, or emphasized how rules, demands and procedures interact with competence, use of estimates and independent evaluation ability. That mistakes arise is often explained by conditions with the employee, for example lack of motivation or will to follow defined procedures. Such an understanding of learning is related to a perspective on safety, which is called Behavior-based safety (BBS). The focus in BBS is directed towards change of workers' behavior to prevent accidents. The underlying aspects of this perspective is to get an understanding of the possibilities for accidents as a consequence of uncertain behavior from workers (IRIS, 2011).

The BBS-perspective is criticized of underestimating and relocate focus away from other and more fundamental factors that can be the reason for accidents happening. Evaluations and actions made by the employee in a concrete situation, for example whether systems and governing documentation is to be used, is done within an operational and organizational context. A consequence of this perception is that the organizational and operational context do not get the proper evaluation. Improvement work subsequent to accidents in a perspective like this will thereby emphasize changes and adaptations of governing documentation and training in use of systems within existing frameworks. The work-context will thereby be the same independent of the changes being made. The approach in this thesis is on the organizational level, and the management system that creates a framework for employees. The management system must be prepared in such a way that employees are guided with safety critical behavior through training.

2.4 Theoretical Summary

Several theories have been deducted in this chapter. The aim is to get a better overview over the problems facing the petroleum industry today, especially regarding the management system, accidents, learning and change. Nevertheless, the most important features of the theory used will be described in this section.

The current view on management systems attaches importance to its vital function to achieve safety. Both formal and informal aspects of the organization are emphasized, because of an increased understanding of interactions between them. The Pentagon Model (Figure 1) serves as a basis for the management system in this thesis. This includes formal structure, culture, interaction, relations and network, and technology.

Regarding accident theory, three different organizational viewpoints were described. These include normal accident theory, high reliability theory, and the resilient engineering perspective. This thesis will take the three theories into consideration when doing research. Nevertheless, the main comprehension is whether it is possible to develop sufficient robust characteristics through the various parts of the pentagon model, and thereby prevent potential major accidents from happening. This is described in figure 2.

Further, learning is limited to only considering learning from own experience, as well as variances detected by third-parties. This can be demonstrated in figure 3, through developing better solutions after an accident has happened. This new experience and knowledge is used to implement changes in the management system. In this matter, there is an emphasis in training of personnel, much because of the Behavior based safety perspective prevailing in the petroleum industry.

3 Research Methodology

In this chapter, the research approach is described in terms of the methodological process, data collection, analysis, quality of the data, and limitations. The study is based on the research question in chapter 1, and hence the four questions deduced to provide guidance in this search. The methodological procedure will be presented by discussing the purpose of the research, research approach, strategy, and the case-study method. The data collection explains the choice of sources, and the interview process. Further, the data analyzed are presented, in addition to reliability, validity, and the limitations of the data.

3.1 Methodological Process

The research methodology is those techniques and procedures used to collect and analyze research data (Saunders, Lewis and Thornhill, 2009).

3.1.1 The Purpose of the Study – Strategy and Design

In the research methodology, the problem to be addressed was weighed heavily when choosing research strategy. There are two strategies which can be chosen to illustrate the research question; a qualitative, or a quantitative approach. It is also possible to use these approaches as complementary, meaning use of triangulation (Ringdal, 2009).

The research design is the general plan of how the research question is answered (Saunders, Lewis and Thornhill, 2009). According to Ringdal (2009) a design is the researchers plan, or sketch for an investigation. There are many different designs, which can be used, dependent on the purpose of the study. Saunders, Lewis and Thornhill (2009) divide these in an explorative, a descriptive, or a causal research. Choice of design will be based on the study's research question and the purpose of the study. This involves several features; what is studied, existing theory, and to which extent the theory can be used to explain the research theme (Hillestad, 2004).

3.1.2 Research Approach

Saunders, Lewis and Thornhill (2009) suggest that it is possible to divide between two types of approaches when doing research. The deductive approach use existing theory, which serves

as a foundation for empiric observations. An inductive approach starts in the opposite end by first observing a phenomenon. Thereby, the existing empiricism is used to create insight into a current problem. This is further solved through hypothesis or a theory.

This research has used existing theory of management systems, potential major accidents, learning, and subsequent change. Research about the Snorre A accident were also available regarding these aspects. Together, this have served as a foundation when carrying out the research. The goal was not to create new theories, but to use existing theory and collected data to create insight into a current problem. Therefore, the study has both deductive and inductive features.

The research question creates a platform for a hypothesis testing, which will be analyzed and discussed in this thesis; If Statoil's management system is sufficient to prevent potential major accidents from happening at the Snorre A platform, compared to the situation in 2004. Four questions have been deducted to provide guidance in this search. This includes if Statoil has complied with the requirements imposed by the PSA, to what extent learning has led to changes in the management system, what these changes have been, and if the current management system ensures safety.

3.1.3 The Case Study Method

In this master's thesis, the case study is used as the research strategy, since the objective is to explore, and analyze an empiric phenomenon. According to Yin (2003) a case study is an empiric investigation of a phenomenon in its natural environment, where several data sources are used. Robson (2002) further argues for the advantage of going in depth, and to get a profound understanding of the problem.

The case study to be explored is the Snorre A platform, with a point of departure in the blow-out happening in 2004. This was a peculiar case, where many factors in the management system failed. Changes in the system have been implemented since 2004, but the question is whether these changes are sufficient to prevent other potential major accidents from happening. The case will be further described in chapter 4.

As mentioned, Saunders, Lewis and Thornhill (2009) described three different types of studies to be used. Explorative studies are appropriate if there is no evident comprehension to the problem, and if there is a desire to define this more precisely. A descriptive study is used to describe the reality as detailed as possible, while a causal study is testing of hypothesis in causal relations. A descriptive study have a relative good understanding of the problem-area, however, there is a desire to further investigate elements that can create correlation between variables (Johannessen, Kristoffersen and Tufte, 2011). This research will be relative explorative, but also have considerable features of a descriptive study. The findings cannot be generalized, however the results can be used as an interesting implication for further research. Summarized, this thesis is an exploratory and descriptive study of whether Statoil's management system is sufficient to prevent potential major accidents from happening at the Snorre A platform.

3.2 Data Collection

Data collection methods can be divided into two categories; primary- and secondary data. Primary data are sources collected by the researcher, in this case through interviews, whereas secondary data are sources that other people have collected, which is usually used for other purposes.

Both primary and secondary data can be divided in two categories; qualitative and quantitative data (Ringdal, 2009). Quantitative data are based on numbers and are numerical and standardized. Qualitative data, on the other hand, are based on sense through words, which are non-numerical and non-standardized (Saunders, Lewis and Thornhill, 2009). The emphasis in this study is on qualitative data, but quantitative data is also used through reports and previous research. This contributes to secure validity and reliability (Yin, 2003), and is called triangulation. This means to use multiple data sources to get a better understanding of what is explored, with the purpose of confirming the same facts (Ringdal, 2009). The availability of research is extensive, both regarding theory presented in chapter two, as well as secondary sources discussed in chapter six. Secondary sources includes underlying causes of the accidents, initiatives reports carried out by Statoil, reports on the implications for the organization, and to which extent the organization has learned from the accident. Therefore, it has been important to use this existing research as a foundation when carrying out this work,

and supplement own findings through qualitative interviews.

3.2.1 Secondary Data

This research was initiated by collecting secondary data. The objective was to get deep insight in existing theory about the several themes important for the thesis. Secondary data has been very important when carrying out this work, much since not having direct access to Statoil's organization, and because much research has been done in connection with the Snorre A accident, as well as similar accidents in posterity. The availability of investigation reports, research, and articles regarding the underlying sources of the Snorre A accident, as well as implications for Statoil's management system after several initiatives conducted, are many. This includes, among other things, the IRIS report, SINTEF report, and much work carried out by Schiefloe and Vikland (2005;2006;2007).

The advantages with use of these sources, are the low degree of cost and time to collect it. However, when using these sources, the importance of securing reliability and validity was considered. One of the greatest problems when using secondary data, is that the data used are collected for other purposes. Hence, the information may not always be suitable to illuminate the research problem. Further, a lack of knowledge of how the secondary sources have been collected implies difficulties of knowing how representative the sources were. An evaluation was therefore made to use multiple sources, to find proof of validity and reliability. The most relevant appraisal criteria used in this thesis was the current interest of the problem, who has collected the data, the motive behind the data collection, methods, sample and sample methods, and possible sources of error.

3.2.2 Quantitative Data

Quantitative data was used through the secondary information collected. This has provided with statistics and measures in the analysis. These have helped in the support of findings in the result, and also to reveal disparities between primary and secondary sources.

3.2.3 Primary Data

Primary data are sources that have been collected for the purpose for this thesis, through interviews. Two important decisions was how many informants to use, and how to choose these to get a best possible result. Since a qualitative method was used in collection of primary sources, a limited number of informants was sufficient. These were chosen strategically to get various viewpoints and insight of the research question. Interviews were carried out with seven informants, having various backgrounds related to the Snorre A accident, and Statoil's management system.

The interviewed people in this master's thesis were:

1) Person working at the Snorre A platform when the blow-out occurred (Currently working at another platform at Statoil)
2) Doctor, scholarship-holder/researcher at NTNU, which contributed with the causal analysis after the Snorre A accident
3) Senior researcher with PhD in Social Anthropology at NTNU. Participated in Statoil's internal investigation, and in an evaluation of initiatives at Statoil.
4) Two principal engineers working at the Well and Drilling department at the Petroleum Safety Authority Norway
5) Person currently working as Leader and former Leading Advisor in a discipline covering safety technology in Statoil, Stavanger
6) Comments from Land Chief at Snorre A

3.2.4 Qualitative Method

The qualitative method is based on a social constructed world through the actions of the individual. This means that a social phenomenon is not stable, but in continuous change.

A qualitative method was used since the problem to be addressed in this thesis is complicated. It was a search for an understanding around Statoil's management system, and its implications for potential major accidents and safety. The theories derived are a basis for the primary and secondary sources, and to find out whether the research problem can be supported by evidence.

Using a qualitative method when collecting primary data made it easier to understand, and to get an overview of the research problem. This, because it is difficult to find all the variables and values that can affect the problem to be addressed.

3.2.4.1 Qualitative Interviews

The objective of a qualitative research is to achieve comprehensive information from informants about experiences, thoughts, and feelings. To achieve this it is important to encourage the interview person to describe their situation in own terms (Lilledahl and Hegnes, 2000), which was done when carrying out interviews.

According to Lilledahl and Hegnes (2000) there are different ways of carrying out an interview:

1. Unstructured interview: In an unstructured interview, there is a theme, but the questions is adapted to the specific interview situation
2. Structured interview: In this interview the theme and formulation are decided upon in advance
3. Semi-structured interview: The most common type of interview. This type has an interview guide as a starting point, however the questions and themes and its sequence can vary

This research was carried out by using both an unstructured, and a semi-structured technique. This means that an interview-guide was used as a starting point when carrying out the research. However, since the informants had varying backgrounds, and different connections to Statoil, the interviews were adapted to the specific interview object. In addition, follow-up questions, which were not decided upon in the first place, were also asked to ensure that as much information as possible was generated.

The interview guide was designed in advance of the interviews. This included themes, sequence, and formulation. This preparation increased the scope of the data, and made the data collection more systematic. In addition, by doing this, potential gaps were to a greater extent foreseen, and filled. However, each interview was adapted to informant, since they had different positions and connections to Statoil and the Snorre A accident.

By choosing to perform most telephone interviews, time and costs were saved for both parts. Most of the informants were located in various parts of Norway, hence natural to carry out interviews by telephone. Both personal- and telephone interviews were suggested to the informants, however, most of them found a telephone interview more suitable.

3.2.4.2 Telephone Interview

The telephone interview was the most applied interview method, and therefore the primary source of data collection. This was much due to geographical distances, and also a request from some of the informants. This was both time- and cost saving, hence advantageous for both parts. The telephone interview was easy to arrange, by sending out e-mail to the potential candidates. Most of them answered quickly, and was willing to contribute to answering questions.

Disadvantages noticed when using telephone interview were that questions must be formulated in a certain way to avoid misinterpretation. In addition, the interviews should not take too long time. The average time of the telephone interviews was about one hour with each of the informants. Also, another disadvantage is the lack of visual representation and little control of the environment of the respondent (Kunnskapssenteret, 2013c).

3.2.4.3 Personal Interview

The personal interview was also used. This was due to being geographical near to the respondent, and also to get an in depth conversation.

Advantages noticed when using personal interviews were the flexibility, and a nearness to the informant. It was also easier to ask questions more in depth. A personal interview also gave the best control possibilities, since the respondent's identity could be considered (Kunnskapssenteret, 2013a).

The disadvantages is the possibility of affecting the informant, and to construct answers by mistake. In addition, this method is considered as more costly and demanding in resources. This was however not the case here, other than travelling costs. The informant was near in geographical distance, and a choice was therefore made to get a personal interview.

3.3 Analysis of Data

When the telephone interviews were carried out, questions and answers were written down simultaneously as they answered. This was subsequently translated into English, which prevented the analysis from using direct quotation.

When carrying out the analysis, the data material was organized by creating different paramount themes where this was possible. In most interviews, there were certain aspects which was not covered by other interviews. This means lack of generalization, however, it also provided with various input and viewpoints on several themes.

A theme-based approximation in thread with Thagaard (2009) was used, which means that a comparison of information was made based on each theme for all informants. The main point was to attain a deeper understanding for each theme across the study objects, and at the same time look at similarities and differences. A drawback of an approach like this is the possibility of losing overview of the totality in the material, since bits of the content is disengaged from the context. To avoid this, a total impression after the interviews were written down. The intention was to ensure that a broader perspective was maintained. Also to have the possibility to look back at the document to see if notes corresponded to the conclusion.

3.4 Quality of the Data

When carrying out this research, an emphasis was made on securing good quality in the data collected. However, this can be difficult when collecting secondary data. The way to secure this was to use reliable and acknowledged sources from multiple actors. In the qualitative interviews, the concepts of reliability and validity is central in the discussion of the research's credibility (Saunders, Lewis and Thornhill, 2009; Thagaard, 2009). In the following sections, there will be a discussion of the quality of the data material.

3.4.1 Reliability

Reliability in connection with qualitative studies is referred to if the research results are consistent and credible (Kvale and Brinkmann, 2009). An important question is whether alternative researchers using the same methods have similar conclusions (Thagaard, 2009), or

if the conclusions can be reproduced at another time by other researchers (Kvale and Brinkmann, 2009).

There are four threats to reliability according to Robson (2002):

1) Subject or participant faults
2) Subject or participant bias
3) Observation faults
4) Observation bias

Since the informants were chosen with an objective of getting various viewpoints to the research question, all the informants had different backgrounds. This was to get a broader overview, and to not get locked in one profession's opinion. However, this means lack of possibility to support the individual's statements, and also the possibility of not getting correct results. This was tried solved slightly by including more informants, however, not all contacted were willing, or had time to participate in an interview.

Observation faults, or bias, can arise when the informants are in situations that is not consistent with their normal behavior pattern, and hence lead to atypical answers. Observation faults can arise if informants give inaccurate answers with the purpose of distorting the results (Saunders, Lewis and Thornhill, 2009). In this study, secondary data as Statoil reports, or media coverage with intention to decorating truth, or intention to criticize the company was considered. Also, the informants could have answered question in a way that does not reflect reality.

The work was carried out by ensuring that reliability was accounted for through choice of method, and arguments for why this is chosen. Further, all available sources will be available in the bibliography. However, there is always a possibility that interpretation and analysis of data can carry some subjectivity to a certain extent, which can contribute to weakening the reliability of the thesis.

3.4.1.1 During the Interviews

Saunders, Lewis and Thornhill (2009) argue that the way the interviewer behave during the interview can create disalignment of how the informant answers the questions. This will

impair the reliability if it leads to the informant formulates its answers or avoid talking about important themes.

To get credible answers in this research, open questions were used where it was possible, since leading questions weakens reliability (Saunders, Lewis and Thornhill, 2009). One factor that might have had negative influence on the informants, and thereby the data material, was that I had no interview experience (Johannessen, Kristoffersen and Tufte, 2011), and was therefore very insecure in the beginning. This might have led to much focus on how to carry out the interview, instead of focusing about the informant and the theme of the interview (Kvale and Brinkmann, 2009).

This way, important information could have been lost along the way. However, after a few telephone interviews this became less stressful. Being aware of these problems before starting the interview, reading methodical books, and articles helped in this process. Also, since both questions asked and answers written down simultaneously as the informants answered, important information could have been lost. In addition, conducting the interviews alone was a bit challenging.

3.4.1.2 During the Analysis

After the interviews were executed, the answers were transcribed from Norwegian to English. Since the information collected through the interviews were not taped, and therefore could not be listened to subsequently, it was important to analyze the findings immediately after the interview was completed. The answers were structured in a way that information was related to different themes. In addition, all the data material was structured by giving each informant a particular color. This was done to keep an overview over which informant said what, when comparing and gathering all the data material in one document.

The transcription process has great impact on the reliability of the data (Kvale and Brinkmann, 2009), and was considered when drawing conclusions from the data material.

3.4.2 Validity

Validity is another criteria, which needs consideration to ensure good quality of data. Validity is about the degree to which the data set generated from the research approach reflect the

phenomena that it is intended to cover (Piekkari and Welch, 2004).There is a division between internal and external validity. According to Yin (2003), internal validity about establishing a causal relationship where certain relations can lead to other relations, parted by other apparent relations. This is often hard to examine, however, through accurate and thorough documentation of used data this will increase the internal validity. Also, the concept validity is increased by the choice of the case study. However, because of the study's limitations, it is no possibility of including all aspects which can influence the research question. However, these will be mentioned in the conclusion.

External validity is whether the findings in this research can be generalized in other research settings (Saunders, Lewis and Thornhill, 2009). As mentioned, because of the study's uniqueness there is no objective of generalizing the results. However, the findings in this study can, to a certain extent, be transferable if similar cases should arise at a later point.

3.5 Limitations of the Data

There are direct links between the types of data collected, the data collection process, the interpretation methods, and the chosen research strategy in this research process. In relation to these links, it is also important to understand the limitations, as well as possible factors affecting validity and reliability of the research. Failures and mistakes can occur at any time in the process, from collection of data, processing, analyzing, and the conclusions drawn.

3.5.1 Data Collection

An important weakness in the qualitative analysis is that my perspective and background can affect choices and interpretation of the text, and lead to an imbalance in selection of texts. However, a thorough consciousness about this problem has been made throughout the work, and also choosing to include text showing several viewpoints on the problem.

Further, an observation was made that many of the sources served a certain purpose. Also, when using Statoil's own reports, careful considerations was made due to these might have been written for a special purpose, and the possibility of leaving important information due to the company's reputation. An emphasize has therefore been made to get information from

recognized sources as the IRIS report, PSA's investigation report, SINTEF report, reports on measurements of effects, as well as Statoil's viewpoints on the accident and implementation of initiatives.

3.5.2 Data Sample

The selection in this research is not representative, but strategic, since it is based on few samples (Lilledahl and Hegnes, 2000). However, even though the findings are not representative to the population, it can be representative in the categories investigated (Kunnskapssenteret, 2013b).

Only seven people were interviewed, which leads to limitation regarding collection of enough support for answering the research question. Also, a question becomes whether the right people were interviewed. To get more support for the conclusion, more people should have been interviewed, preferably within the same area of expertise.

There are several drawbacks which are important to highlight when using an interview-guide, which also made this research demanding. This is for example that vital themes can fall in between, and that the flexibility can give different answer perspectives, and make comparison of data difficult (Lilledahl and Hegnes, 2000).

3.5.3 Interpretation Methods and the Chosen Research Strategy

The interpretation methods and the chosen strategy are also important to consider. When interpreting data, it is always a danger of interpreting from an own point of view. This was tried solved through using other secondary sources. Further, the research strategy can also limit the results, since it is no possibility to get statistical generalization when executing the case study. This was considered when choosing this method, nevertheless, the case study was considered as suitable.

4 Empiric Background

The empiric background serves as a foundation for the research carried out in this master's thesis. A short presentation of the different actors involved will be introduced; including Statoil, the Snorre A organization, and the Petroleum Safety Authority Norway. In addition, the main features of Statoil's management system important for solving the thesis will be deduced. Finally, the Snorre A blow-out and its underlying causes will be presented in form of the pentagon model.

4.1 Description of the Relevant Organizations

4.1.1 Statoil ASA

Statoil ASA is an international energy-company with 40 years of experience from oil-and gas production on the Norwegian continental shelf. The headquarters lie in Stavanger, Norway. Statoil is listed on the stock exchange in New York, and in Oslo (Statoil, 2013b).

"Den norske stats oljeselskap AS", Statoil, was established in 1972. Only two years later, the Statfjord field was found in the North Sea, and Statoil was the first Norwegian company that got operator responsibility on a field, on Gullfaks in the North Sea (Statoil, 2013c).

In October 2007, Statoil merged with Hydro's oil and gas activities. The new company got the temporary name StatoilHydro, and got a size and strength of a comprehensive international initiative. In November 2009, the company changed its name to Statoil ASA (Statoil, 2013c).

Statoil has been one of the most central actors in Norwegian oil-industry since the early 70s, and contributed to developing Norway to a modern industrialized country (Statoil, 2013c).

4.1.2 Snorre A

Snorre A is one of Statoil's large oil producing installations on the Norwegian continental shelf. It is an integrated living quarters, drilling, and production platform, anchored to the seabed with tension legs, and with two subsea production facilities tied to the installation (Brattbakk et al., 2005).

The Snorre A field has a rather turbulent history. It was originally found, developed and operated by Saga Petroleum in 1992. Saga was a private-owned company, and the smallest of the three operating Norwegian companies. Throughout the nineties, there were considerable falling oil prices, and some unfortunate investments and strategic decisions made by Saga. Saga came into deep economic difficulties, and was in 1999 jointly taken over by Hydro and Statoil. Hydro and Statoil divided Saga's properties and licenses between them. With the Snorre field, they found a solution of Hydro being the operator for a two-year period from 2000, where Statoil took over responsibility in 2003 (Schiefloe and Vikland, 2006). Also, at the end of October same year, Snorre A changed drilling contractors from Prosafe to Odfjell Drilling. Odfjell Drilling took over about 80% of Prosafe's Snorre A personnel (Brattbakk, et al., 2005). However, the Snorre A organization, both off- and onshore, was largely kept intact (Schiefloe and Vikland, 2006).

In the Snorre organization, there is a general perception that Snorre A is one of the Statoil facilities with the worst HSE rankings/statistics. Already in September 2003 there had been many notifications regarding four serious incidents at the platform (Brattbakk, et al., 2005).

4.1.3 The Petroleum Safety Authority Norway

The Petroleum Safety Authority Norway ensures that the players in the petroleum activities maintain high standards of health, environment, safety, and emergency preparedness through stipulation of premises and follow up. The purpose is to contribute to create the greatest possible value for society (PSA, 2013b).

The Petroleum Safety Authority Norway was established in January 2004 as an independent government regulator. The organization is subordinate to the Ministry of Labor, and has regulatory responsibility for safety, emergency, preparedness, and the working environment in the petroleum sector in Norway.

The government has given them following duties:

1. The PSA will ensure that petroleum activity and activities relating to it are supervised in a unified manner. This will be done through its own audits and in cooperation with other regulatory authorities in the HSE area
2. The PSA should be a contributor of transfer of knowledge from the HSE area to society in general. This will be done by providing information and advice to the

companies in the industries, establishing collaborative relationships with other HSE regulators nationally and internationally.

3. The PSA will provide input to the supervising ministry on issues being dealt with by that ministry, and support the ministry on issues at request.

4.2 Statoil's Management System

Statoil's management system is a set of principles, policies, processes and requirements that support the organization in how to reach their objectives. It is about how to get from A to B in a secure and effective way, and a basic navigation tool intentioned to be used in every area, as well as under changing circumstances. Beyond the main features of Statoil's management system, only parts relevant for the research will be discussed here.

"At Statoil, the way we deliver is as important as what we deliver" (Statoil, 2013a).

The management system is documented in governing documentation. This includes the Statoil Book, common function requirements, and requirements specific to the business area. The Statoil Book describes the common framework of the management system, and is an important remedy in the daily operations. It sets standards for how to behave, deliver and lead. It is clear on what is expected and required from employees, as well as contractors (Statoil, 2013a).

The management system has three main objectives.

1) It is supposed to contribute to safe, reliable and efficient operations, and enable compliance with external and internal requirements.
2) Incorporate values, people, and leadership principles in every operation.
3) Support business performance through high-quality decision-making, fast and precise execution, and continuous learning.

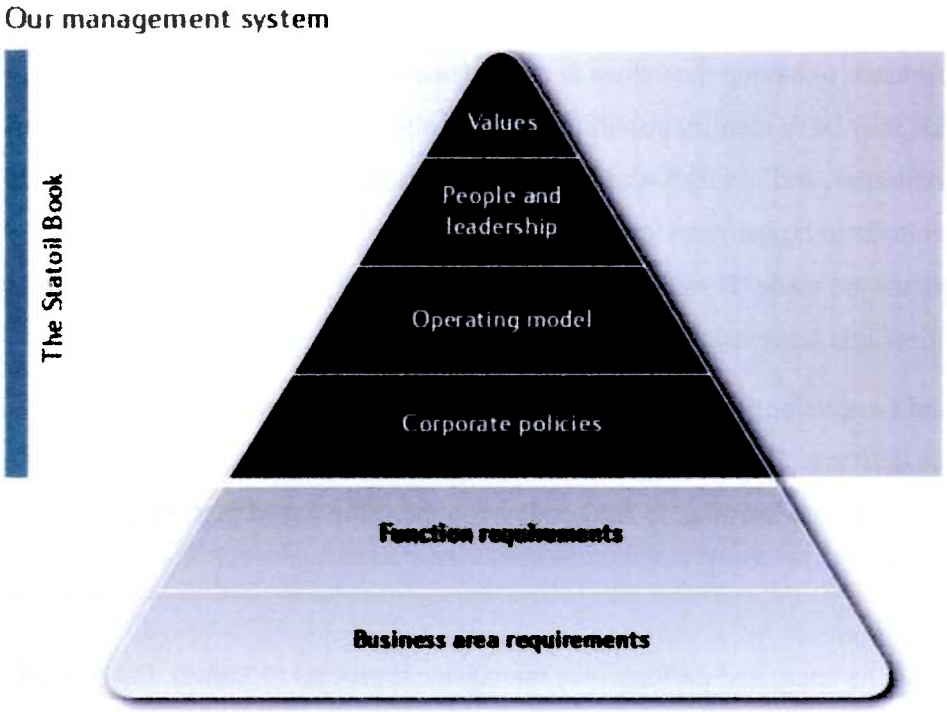

Figure 4: Statoil's Management System

(Statoil, 2013a)

4.2.1 The Statoil Book

The Statoil Books covers the following topics: Values; guiding behavior, People and leadership; describing what they expect from people working in the company, Operating model; describing the organizational principles, the way they work, and the way they manage and improve performance, and Corporate policies; describing governing bodies, authorities, internal control, and regulate actions and decisions in important areas.

4.2.1.1 Culture

Culture is an important mechanism to management in Statoil, and is described in the management system through values, and compliance and leadership principles.

"It is our people who enable us to meet our challenges and deliver on our promises. We need your skills and personal commitment as well as effective leadership to reach our goals." (Statoil, 2013a).

Statoil's values are to be courageous, open, hands-on, and caring, which lies at the core of the management system. These embody the spirit, and energy of the company, and are essential to succeed over time in a competitive environment. The values drive performance, and provide

guidance in how to do business, and how to work together with external stakeholders. Statoil emphasize the importance of having the values in mind when making the right decision. In a certain situation, this may be to identify possibilities and challenges, to have integrity, to show engagement and endurance, and to make sure that no accidents happens. It is not acceptable to make decisions that leads to higher risks, and it is therefore important to clarify the task to ensure that no shortcuts are made. Performance of employees is not just evaluated on what is achieved, but also how it is achieved (Statoil, 2013a).

The Compliance and Leadership (former A standard) way of working enables continuous quality performance delivery. The active use of the management system in the daily work ensures precision, quality, and learning, to further develop the value-based performance culture (Statoil, 2013a).

4.2.1.2 Ambition to Action

Ambition to Action is the integrated performance management process at Statoil. Because of the demanding, dynamic, and unpredictable business environment, a focus is put on continuous risk evaluation. This, to respond quickly when the unexpected occurs, and when opportunities or threats arise. Ambition to Action balances alignment of strategic direction and common business processes, with empowerment and local business responsibility.

4.2.1.3 Operating Principles

People working at Statoil need to comply with the rules and procedures adopted. These create a common standard for how operations should be carried out. Statoil has five operating policies that guide behavior, actions, and decisions for the entire company.

1. Value and performance is created in the combined asset-based and function-based organization
2. The organizational entities have clear responsibilities, and two distinctly defined roles; the line role and the support role
3. Responsibilities and authorities is established through the process of delegation to the line role, and through the assignment of tasks to support roles in delivery entities
4. A single point of accountability applies
5. The line role has primacy, and acts in accordance with the management system

4.2.1.4 Risk Management

Statoil identifies, evaluates, and manages risk in every activity to provide safe operations. In the risk evaluation, a focus is put on both up- and downside effects in every level of the organization.

Monitoring is conducted to manage risk, and to drive performance and learning. It ensures quality, and efficiency in how to do business, as well as the quality of the products and services provided. It assures compliance with the management system, provides as a basis for improvement, and is performed by both internal and external parties. The scope and frequency of internal monitoring depends on an assessment of risks by line managers, process owners, and corporate staff functions.

4.2.2 Function Requirements and Business Area Requirements

The function requirements describes the requirements for common process areas, work processes, and technical requirements. Business area requirements describes the organization and the operating model for the business areas, and other organizational units. Business area requirements also includes local governing documentation related to the common process areas.

4.2.2.1 Governing Documentation

The global governing documentation ensures standardization, and deployment of best practice across the group. The process models and work flow diagrams describe how the employees should execute work processes, including requirements of the activities. The owners of governing documentation handle proposals for improvements and applications for dispensation. Governing documentation is owned by process owners, or corporate staff functions. The IT tools in the management system gives easy access to governing documentation through Entry. Synergi does also function as a site where employees can update information of incidents, and sharing of knowledge. Further, courses and e-learning programs areavailable in the course-catalogue (Statoil, 2013a).

4.2.2.2 Arenas

Statoil has an organizational structure composed of business units with processes across functions, and is thereby a mixture between a functional and matrix organization. The purpose of the arenas is to provide quality and consistency across the organization before important decisions are made. The arenas ensure that decision-makers understand expectations for the result, that risk exposure is realistic, and that decision-making meets the requirements.

4.2.2.3 Process Owners

The mentioned business arenas are line organized and process users. Process owners have been appointed for the significant process areas with a global reach affecting large numbers of people across the organization, and to support business needs and standardization based on best practice. Working across the organization, process owners ensure that high operational standards and functional excellence are achieved. Process owners capture best practice and lessons learned, and incorporate this into the global work processes (Statoil, 2013a).

4.3 The Snorre A Blow-out and its Underlying Causes

4.3.1 The Snorre A Blow-out

November 28, 2004 a gas blow-out from well P-31A occurred at Snorre A. Gas was detected on the surface below the platform. Of the 216 people on board, 35 people stayed behind trying to prevent the blow-out from escalating. The flare continued to burn simultaneously as they tried to solve the problem, which was a potential ignition source for gas from the sea (Brattbakk, et al., 2005). Because of the work carried out by these skilled people, they eventually managed to get the situation under control. This without any human injury, or environmental damage (Schiefloe and Vikland, 2006).

The PSA characterized this incident as one of the most serious accidents on the Norwegian continental shelf (Brattbakk, et al., 2005). Only small margins prevented the incident to develop to a major accident with loss of lives, and environmental destructions (IRIS, 2011). Serious failures and deficiencies were uncovered in all phases of Statoil's planning and implementation of operations at Snorre A. The PSA appointed an investigation group, which identified non-conformities and improvement areas categorized into four areas;

1. Lack of compliance with governing documents
2. Inadequate understanding and implementation of risk assessments
3. Inadequate management involvement
4. Violation of well barrier requirement

4.3.2 Analytical Point of Departure

To detect which parts of the management system was not sufficient in 2004, it becomes important to find out what was lacking in the management system. The variances were found

by the PSA, however, Schiefloe and Vikland (2007) have analyzed these findings by using the Pentagon Model presented in chapter 2. This is to get a better overview over which parts of the management system was not intact when the accident happened.

4.3.2.1 Formal Structure

Schiefloe and Vikland (2006) found two sets of formal factors having vital significance on the weakening of the safety barriers. The first comprise the three organizational changes, while the other is about the governing documentation. None of the three change processes were of dramatic character; however, the joint effect was a temporary weakening of the Snorre organization, especially in relation to planning and surveillance of technical demanding and complex operations (Schiefloe and Vikland, 2007).

The first set of organizational processes has to do with the shifting of operators, from Saga, to Hydro, and Statoil. Although this was done "by the book", hence giving those who wanted a possibility to continue in their old jobs, the processes was strenuous to the organization. This was due to people adjusting to new managers, new data-systems, and governing regulations. In the last organizational change, from Hydro to Statoil, there was a clear message from the organization of wanting to be "left alone". This was noticed by management at Statoil, and therefore only minor changes of operating practices were done the first two years (Schiefloe and Vikland, 2006).

The second set of changes took place in the well, drilling, and underground departments onshore. When Saga was operator, as well as Hydro, the activities were organized in two different sections; one for petroleum technologies and geological analysis, and one for drilling and well operations. Statoil's practices were different, and the two sections therefore merged and named RESU (reservoir and underground technologies). This led to new ways of cooperating and coordinating activities, as well as new working procedures. In addition, a reorganization compromising all Statoil RESU activities in the Tampen area were made. The purpose was to get a better use of the combined competence and resources in these extremely specialized groups of geologists and engineers. This meant that the Snorre organization had to adapt to another set of leaders, and to a new professional environment. Also, heavy burdens of work and much responsibility on a few experienced leaders brought the Snorre A RESU out of balance (Schiefloe and Vikland, 2006).

The third set of changes took place in the drilling department at Snorre A. The drilling operations were outsourced to firms specializing in these kinds of activities. On November 1, 2004 there was a change of drilling operator, since the earlier bidder lost a renewal of the

contract. Norwegian labor laws states that employees in such situations have the right to continue their jobs, which most of the workforce did. However, they had to adjust to a new set of leaders, and some new formal regulations. These adjustments took time and meant extra work. It also drew some attention away from the daily work processes. None of these change processes were dramatic, however, the combined effect was an overall weakening of the Snorre A organization. This was especially concerning planning and monitoring of technically complex and demanding well operations (Schiefloe and Vikland, 2006).

A general discovery made by Schiefloe and Vikland (2006) in the official investigation report, were many violations in using the governing documentation. This was a distinct subject under the collection of data. A thorough finding was an explicit loyalty to the regulation. The employees did understand the importance of the regulations, and there were nothing implying that rules were broken intentionally. At the same time, many were of the opinion that the regulations were too comprehensive and difficult to follow, and that parts of it was too detailed and specialized. Sometimes it was also difficult to divide between absolute demands, and what was guiding parameters. Hence, the knowledge of the regulations were varying, and some of the informants told that they could not guarantee to have full overview over all the rules they had to comply with. The governing documentation was systematic organized in databases that were easy to use for experts. However, not everyone was comfortable with use of computer equipment, and that complicated the situation further for those working off shore. These employees work to weeks on and four weeks off, and thereby four weeks until next time logging on to the database. At the same time, there were continuous extensions, specifications, changes, and updates assumed they had knowledge about (Schiefloe and Vikland, 2007).

4.3.2.2 Culture

Snorre A was the only installation operated by the former Saga Petroleum. Throughout the history, there had been a high degree of personnel stability and limited turnover. Being as an island by itself, it came to develop a relatively marked internal culture. There are some aspects of this culture which is of special interest. Firstly, the working environment was characterized by a feeling of internal solidarity, with people having a strong and expressed identification with the organization (Schiefloe and Vikland, 2007). A positive effect was a motivation of doing a good job, and keep production going, in spite of many technical challenges. The informal climate was friendly and including. The employees felt an identification with the installation and colleagues, which also was proven when people

volunteered to remain on board to fight the blow-out. No one was forced to stay, or would have been criticized if they had evacuated the platform. Still, they wanted to get the situation under control together with their colleagues. Those evacuated also said they wanted to stay and contribute, since they did not want their friends to take the risk alone (Schiefloe and Vikland, 2006).

To find the time to develop competencies concerning systematic risk assessment has been demanding. Due to limited size of the onshore organization, the number of experienced technical personnel was limited, thereby depending on a few persons. Snorre has had a history of few authoritarian leaders in the Saga period, which influenced the climate for internal criticism in a negative way. There was also a high risk tolerance at Snorre. They never felt they took chances, but as many of the findings demonstrates, they did (Schiefloe and Vikland, 2006).

4.3.2.3 Interaction

Both Statoil and Hydro have a clear policy regarding safe operations, which is demonstrated through an extensive reporting system for incidents, and near incidents. When something happen, both personal injury and technical break-downs, precautions shall be taken and reported. However, practicing the ideals were sometimes difficult. This was because of a continuous pressure to keep up production, a scarcity of time, diverted attention from leaders, and because of difficult consideration in decision-making. From the outside, the working processes can be characterized as shifting towards a risk-prone practice (Schiefloe and Vikland, 2006). The work program was often completed immediately before execution, and the leaders had small possibilities of controlling the work that was done at the land organization. They were used to "trusting the experts" (Schiefloe and Vikland, 2007).

Interaction between the on- and offshore organization also had a historical dimension. The interviews showed evidence of negative experiences when people at the platform came with critical notations, or questions to assessments made by those working onshore. Attitudes that the safest thing was to keep quiet, and do what was told, had survived through the change of operators. This, in spite of clear messages from management in Statoil; *"If there is any doubt about circumstances of safety critical character, the work is to be stopped, irrespective of costs"* (Schiefloe and Vikland, 2007).

4.3.2.4 Relations and Networks

The day when the blow-out occurred, Snorre A had been a part of Statoil in almost two years. In the organizational map, the installation was placed in the Tampen area in DPN equally to

all the other Statoil operated platforms. However, the organizational map did not tell the whole truth. As a consequence of the decision of keeping the Snorre organization relatively intact after the change of operators, Snorre A was in another situation than the other fields. Those working at Snorre, had a background from Snorre Petroleum, and was not in the same way informal and social integrated in the bigger operating organization. Few leaders had come from Statoil, and there were weak informal and loyal bonds coupling the Snorre employees together with their new colleagues in other parts of Statoil (Schiefloe and Vikland, 2007). In addition, there was not sufficient contact or cooperation with the neighbor installation Snorre B (Schiefloe and Vikland, 2006).

Contemplated in a network perspective, Snorre A appeared as a relatively isolated unit. This made Snorre A a different installation. This is since one of the characteristics with Statoil is the extensive, informal networks which couple people together in various parts of the company. This far-reaching network is to a large extent a bi-product of Statoil's rotational policy, which means that most employees change place of work with a few years of interval. This is especially for leaders and specialists (Schiefloe and Vikland, 2007).

In the process leading to the blow-out, those working at Snorre RESU had few possibilities of making use of the informal professional relations to get advice, or to discuss alternative technical solutions for the actual well operation (Schiefloe and Vikland, 2006). This special operation had not been experienced before. However, later they realized that they had carried out a similar operations a few years earlier, and that they both had experience and the correct equipment necessary. After the blow-out was stopped, and the situation was normalized, many professionals from other parts of Statoil came to help. One of the informants said they did not know that so much experience and expertise was available at Statoil (Schiefloe and Vikland, 2007).

4.3.2.5 Technology

The technological standard at the platform had been gradually deteriorated due to long-time wear-and-tear, lack of maintenance, and limited redundancies. The investments had been kept to a minimum, which resulted in an incident-driven mode of working (Schiefloe and Vikland, 2007). "Continuous fire-fighting" was an expression used to describe the daily working situation for those working at the platform, both regarding operations and technical maintenance. A consequence of this was lack of possibilities of long-term planning and systematic work on the technical installation. However, it also led to a well-developed ability to improvise in any situation. The Snorre A crew could handle almost any technical challenge,

which also came to play a decisive role in handling the situation when the blow-out occurred (Schiefloe and Vikland, 2006).

The explanation for the state of technology was found in the platform's turbulent history, as well as the problematic economic situation of the first operator of the field, Saga Petroleum (Schiefloe and Vikland, 2007). Saga tried to keep costs down, and at the same time keeping production at a highest level possible. This did of course influence the work practices, and created a tolerance for taking a few short-cuts when it was considered necessary. This situation was not influenced much during the two years Hydro was operator. When Statoil took over the responsibility in 2003, plans were made for a technical upgrade, but had not come very far by November 2004 (Schiefloe and Vikland, 2006).

4.3.2.6 The Barriers in the Organization

Schiefloe and Vikland (2007) have examined how the soft mechanisms, or more precisely, the organizational safety barriers function and grouped them in two dimensions, according to character and function.

The first dimension is divided between barriers of formal and informal character. The formal barriers is every type of decision and arrangement that is integrated in governing documentation, including work processes instructions. The informal barriers include safety related interactions that is not regulated by these mechanisms, which affects how things are done and provides as mechanisms for quality control. Mechanisms of the first type secure that work tasks are done in a secure and right way. The other type implies extra consideration of safety before a critical task is initiated (Schiefloe and Vikland, 2007). This is explained in Figure 5:

	Formal mechanisms	**Informal mechanisms**
Doing the right things	1	2
Quality control	3	4

Figure 5: Formal and informal mechanisms

(Schiefloe and Vikland, 2007)

The reduced organizational robustness in the Snorre organization can be explained in forms of weaknesses in all these categories in the table. The failure of following the decisions of governing documentation can be placed in category 1. This was partially due to the complexity and availability of the documentation (Schiefloe and Vikland, 2007).

Lack of management involvement and lack of control of the well program can be placed in category 2. The main explanation is the work-load placed on leaders, the general administrative operations and the comprehensive changes that the organization went through (Schiefloe and Vikland, 2007).

The misjudgment in the planning process can be placed in category 3. The underlying causes had to do with the developed work practice. At the same time, the relative isolation in relation to the informal networks in Statoil meant that they did not have sufficient access to external expertise and counselling (Schiefloe and Vikland, 2007).

The gradual increase of risk tolerance, in combination with the experience of stress and pressure on production, were features characterizing the organization. In all, this led to a relative low degree of informal control of the work practice internal in the organization. These factors can be placed in category 4 (Schiefloe and Vikland, 2007).

5 Results

In this chapter, the results from the interviews are presented. They are organized accordingly to the four questions presented in chapter 1:

1. Has Statoil managed to comply with the requirements imposed by the Petroleum Safety Authority Norway after the Snorre A accident?
2. What changes have been made in Statoil's management system since 2004?
3. To what extent has learning from the Snorre A accident led to changes in the management control system?
4. Does the current management control system ensure safety?

Under each of these four parts, there are questions related to the interviews conducted. These answers will give contribution to the further discussion in chapter 6. In chapter 6, results from secondary sources will also be presented and discussed together with the results presented in this chapter. In all, this will make the foundation for the conclusion in chapter 7

5.1 Has Statoil Managed to Comply with the Requirements Imposed by the Petroleum Safety Authority Norway after the Snorre A Accident?

The investigations reports are important tools to uncover faults, shortcomings, and improvement areas. This may contribute to prevent such accidents in the future. When the PSA investigate, their focus is to uncover variances that Statoil must close. When Statoil investigate themselves, this is followed up by proposed initiatives. Initiatives are therefore composed by Statoil's initiatives after own investigation, and initiatives which contributes of closing variances indicated by the PSA (IRIS, 2011).

5.1.1 The Petroleum Safety Authority Norway's Contribution to Prevention of Accidents

The Petroleum Safety Authority Norway carries out supervision of the petroleum industry in Norway. The organization has different teams, where there is an own supervision team for off- and onshore divisions. The PSA's main priorities is based on the risk level at the Norwegian continental shelf, history, what is happening international, and other accidents. The organization collects information by supervising, go out on offshore installations, carry

out interviews, and measure activities to see if there are any variances. Based on this information, aspects to be emphasize further are found.

The PSA can employ means to get things done. Sometimes, parts of the organization shows good results, while other parts has bad ones. Operations can be stopped if necessary, and impositions can be given– which was done at Snorre A.

A question to be asked is whether, or how, they can employ impositions on Statoil to improve safety, and prevent similar accidents from happening. There is proof of a so-called "tiredness of initiatives". From the interviews with the PSA, it was obvious that they are conscious about this. They stated that it is important to call attention to defects and shortages, but also to contribute to implementing good initiatives. Without sufficient time, they can stress the organization.

5.1.2 Are Every Point from the Investigation Report Closed in a Good Way? Has Statoil Managed to Comply with These Requirements?

The report of initiatives by Statoil after the accident, which was dated 30 November 2005, constitutes the foundation of the description of initiatives that was proposed after the gas blow-out at Snorre A. The report of initiatives contains eight measures implemented by November 2006, whereas half of them directly aligned to conditions at Snorre A. The other four was more of a general character. IRIS (2011) considered the initiatives as being of primary interest. The process of implementation went well, and the different initiatives got one "sponsor" each at different units. Every initiative was implemented, and some were also pursued to other measures. Many of them also had significance beyond the two years of the evaluation.

The informants from the PSA highlighted that Statoil put a lot of effort to find the causes of the accident, and to close the variances. They had frequent meetings with Statoil the following year. Statoil also got a lot of extra work due to initiatives not being fully covered, and they worked for a long time since many of them were not easy to close. In addition, Statoil struggled to measure what effect the initiatives have had on the company. They did not come up with a good way of doing this, hence the PSA closed all variances in 2005.

However, after the initiatives had been implemented, Snorre A was one of the better installations in the company. Other parts of the company struggled more, as for example

Gullfaks C. The Gullfaks C installation experienced an accident in 2010 with many of the same underlying causes as the Snorre A accident. This was due to difficulties of closing variances throughout the company, and the internal initiatives after the Snorre A accident not having sufficient anchoring in the rest of the organization.

5.2 What Changes Have Been Made in Statoil's Management System since 2004?

5.2.1 What Has Changed in Statoil's Management System since 2004?

Statoil's management system has gone through many changes since 2004. It has gone from DocMap, via APOS, to the new system ARIS. DocMap was the system in use at the time of the Snorre A accident, and was considered as bothersome to many. When Statoil and Hydro merged, they started to use Hydro's system APOS. Statoil was characterized as a "loose" company before the merger, in comparison to Hydro's more militant management system. Statoil has now gone over to the new system ARIS, which is much more simplified, with easier search methods.

One informant from NTNU said that Statoil's former management system was characterized by very complex procedures. This was also communicated by employees, who found the system hard to understand. The governing documentation was constructed by professionals, which often led to difficult language being used, and employees not always understanding the documentation. In addition, not everyone was comfortable in reading English. Synergy was also a problem for many, and was not experienced as suitable.

Further, the head of process drilling maintained that operations were document-oriented, where assignments and different work operations were either too little, or too much defined. The workers were not engaged by procedures, much because of this lack of understanding, and not wanting to ask co-workers every time a problem arose. This led to many executing operations in own terms, and much confusion among the members of the organization. This were also some of the underlying reasons for the Snorre A accident. Hence, the construction of the management system turned out to be a great problem.

The PSA clarified that when the accident happened in 2004, the management system was already through a change. Accordingly, the system did not change just because of the Snorre A accident; however, the accident was a contributor of initiatives, and improvements.

The PSA said they feel Statoil has done a considerable simplification of the management system, cleaned up in their documents, and made it more user-friendly. Regarding change management, they also said that the work processes have been made less complex, implying they are more easy to relate to. The head of process drilling at Statoil added that today's system is more developed. It has gone from being document-oriented to process oriented. These processes describe how to perform tasks.

The informant from the Snorre A platform pointed out that the governing documentation in the management system has had sufficient improvement. The tools regarding HSE have also gone through a clean-up operation. In addition, many changes have been implemented to improve Synergi's report function.

However, one of the informants from NTNU mentioned that Statoil has become a little too "military". There are too rigid lines, much because everything has to be defined in form of work orders. The Sarbanes Oxley Act (SOX) regulation of 2002 was emphasized as a significant contributor. This was a bill enacted as a reaction to the many corporate and accounting scandals including Enron, Tyco International and WorldCom. This act implemented new legislation for those present at the New York Stock Exchange. This was done because many companies manipulated information. After this act was actuated, everything must be formalized and traceable. This requires very strict revision, since it should be possible to track every decision, and every action which the employee undertakes. The employees have to document this through computer systems. A strength with this system is a clear and evident distribution of responsibility, however weaknesses are a more bureaucratic organization, less flexibility, and that it does not take variations between installations into consideration. However, ARIS is much better than the chaos that subsisted before.

The PSA claimed that today, Statoil has evident objectives of what is supposed to be done. For example, through implementation of standardization to ensure that processes and tasks are managed in the same way throughout the company. This jointly operational model is used in their daily work. Now, there is harmonization, standardization of processes, and internal

requirements. For example, DPN and TTD is two different divisions of the organization, but work according to the same standards. This is also supported by the informant working at the Snorre A platform.

The land Chief at Snorre A has made a commented about the management system being under continuous development, with an objective of avoiding accidents. This is based on internal and external experience. However, no one can guarantee anything. The informants from the PSA said they think Statoil is on the right path, and that the company steers changes in a good manner. This is also what both management, and those working throughout in the organization are saying. There have been comprehensive work in the entire organization. However, which effect this will have is hard to say now. Changes are not done overnight, and remains therefore only to be seen in posterity if they have positive effects.

5.3 To What Extent Has Learning from the Snorre A Accident Led to Changes in the Management System?

The investigations from both the Petroleum Safety Authority Norway, and internal investigations at Statoil have revealed variances that need to be closed after the Snorre A accident. Learning becomes subject to which degree, and how, Statoil has learned from public reactions and own experiences from the accident. This involves changing systems, behavior and routines.

5.3.1 What Changes Have Been Made in the Management System in Relation to Learning from the Accident?

The PSA described in the interview that Statoil has put down a lot of effort and resources to improve the organization since the accident in 2004. This includes, among other things, the new management system ARIS, simplification of governing documentation, and the jointly processes which should secure safe operations. In addition, there have been a reorganization of drilling and well operations. The employee at the Snorre A platform supplement this by saying that Statoil did a fantastic job after the accident. There were many initiatives throughout the company to improve the organization.

The head of process drilling said that the Synergi report showed good results of Statoil's learning after the accident. There were more focus on distinct operations governing every installation. However, he asserted that when initiatives are implemented, there must also exist

good solutions for carrying them out. When initiatives are implemented, there is always much focus around it, nevertheless, it is not certain that everyone understands it. The researchers from NTNU investigating the accident, on the other hand, said that the learning effect varies throughout the organization.

Nevertheless, after the Snorre A accident in 2004, there have been several accidents. This includes the accident at Gullfaks C, which proved to have many of the same underlying causes. This was implied in interviews from several of the informants, which said that there are many signs that Statoil have not learned so much after the accident. Gullfaks C also had a distinct culture, and they did not manage to use governing documentation correctly. This, due to all the initiatives being implemented.

The informant working at the Snorre A platform clarified that there is much more focus on safety through the management system today. This includes more simplified operations, and a considerable focus on learning from experience. Management and leaders have put high pressure on ensuring safe operations, and making sure employees understand the importance of complying.

The PSA has closed the variances from both Snorre A and Gullfaks C. Statoil put a lot of effort down to close these variances, however, there are no guarantees that every person at Statoil work according to the A-standard (Compliance and Leadership). Many people are working at Statoil, some of them can make short cuts, and cultures can develop. What leaders both say and do in this matter have a lot to say for this development. Leaders must take responsibility, and prevent such things from happening.

The Land Chief at Snorre A commented that Statoil is of the opinion that they have learned from the accident, even if every accident in the future can challenge that opinion. The PSA ended this by saying "only time will show if the changes have been sufficient".

5.3.2 Are There any Features Regarding the Management System and/or Attitudes Today That Differs from 2004, and Thereby Can Affect Prevention of Accidents?

The PSA said that there are evident differences from both management, and those working in the rest of the organization today. This was also confirmed by the person working at the Snorre A platform. There have been a considerable change of behavior, and attitude in

comparison to 2004. Before, the equipment was only checked and maintained in "in every year of jubilee". Also, it was a tendency of carrying out operations in an "American way", and a culture prevailing where there was a "king on top". The informant from NTNU complemented this by saying that there was a fear of bringing up sensitive subjects, and that management had a fixed and clear mindset.

Generally, there have been major changes in Statoil since 2004, including a completely different way of thinking. This is demonstrated through a higher management focus, and standardization of procedures. The other informant from NTNU also stated that there are more focus on the behavior of the employee, and focus on compliance.

The land Chief at Snorre A commented that the management system is under continuous development, and improvement. The difference from 2004 is that the management system is process-oriented. Also, a great difference is a higher focus on major accidents.

The PSA said that Statoil has a clear plan of action, indicated through The Statoil book. There are also clear signs with compliance to the A standard (Compliance and Leadership). Everyone working in the company, as well as contractors, must work according to this standard. This ensures risk evaluation before tasks are initiated.

Statoil has always had procedures controlling how they manage business. These are continuously changing, according to the changing environment. One of the informants from the PSA says that when in meetings with Statoil, they have always been very convincing about what they are doing is the right way. When there is a new way of carrying out procedures, these are regarded the best way at that moment. Now, the A-standard is popular.

The person from the Snorre A platform said that they are more restrained by requirements, and following governing documentation today. They do not have the freedom of solving problems theirselves anymore. In every situation, they have to stop and evaluate if the process is not mentioned in the governing documentation. They also have pre-work meetings where they gather everyone, and go through the plan and operations.

The PSA said that what is important, is to get everyone to comply with the standards, and how to carry out operations best way possible. There have been much focus on A-standard (Compliance and Leadership) in Statoil, however only time can tell if it will be successful.

5.3.3 How is the Safety-culture at Snorre A Today Versus Ten Years Ago With Respect to Understanding/Use of the Management System?

One of the informants from NTNU remarked that the culture at Snorre A was one of the underlying factors of the accident happening at the installation. Most people working at Snorre A had been employed at Saga. This culture was characterized by "living on the edge". The employees showed great flexibility and cleverness, however, they were "butterfingered". Interdisciplinary communities were prevailing, which wanted to have their subjects alone. The PSA also said that people were doing things in their own way. However, when the accident happened, the informant from Snorre A mentioned these characteristics as the reason why they managed to solve the problem and get control over the situation.

The PSA stated that Snorre A have contributed to increasing learning in the organization, but that this incident alone has not lead to all the changes in Statoil. The accident at Gullfaks C, and Macondo, also had many of the same underlying causes as Snorre A. Hence, there have been important change processes after both these incidents. This includes changes in personnel; new people entering the organization, as well as rotation on the platforms. Also, changes have been done in accordance with resources, capacity and knowledge. In total, Snorre A, Gullfaks C, and Macondo have made major accidents and safety a high priority in the PSA's agenda. Statoil has followed very thoroughly, and done a lot to prevent accidents like these from happening again. However, Statoil is a large organization, and it can be difficult to implement changes in the entire organization.

The head of process drilling stated that, with the reorganization, many employees said that installations would blow up owing to this. Statoil listened, but carried out the reorganization anyhow. The "king on top" culture was removed, and this ensured that special cultures were not created. Accordingly, there have been more focus on building a good culture throughout the company. This is important to provide safe operations in the organization. However, he said that regardless of how much effort is put in building new cultures, people are individuals. Individuals make own decisions and can deviate from the rest of the employees. The PSA also said that Statoil has done many things to break the culture existing at Snorre A. Further, the head of process drilling said that there are always people who do not want change. This restructuring has not proven to give major accidents at the Snorre A platform, yet.

Following, the head of process control asserted that the management system is more developed today. This is also true for the HSE focus. HSE was very simple in 2004, where the only restrictions were to remember glasses, gloves, and protective equipment. After the many accidents recently, HSE have gotten a much higher priority. In addition, the installations have a higher status.

The land chief at Snorre A said that today, Snorre A is an integrated part of Statoil. In 2004, Snorre had gone from Saga, via Hydro, and only been a part of Statoil for about a year. The worker from the Snorre A platform is of the opinion that they have a good culture today. It is like every other work-place, it depends on the people who work there, and what environment they create. They also use the management system in every process they do, and experiences a higher focus on safety.

5. 4 Does the Current Management System Ensure Safety?

5.4.1 Is the Management System Improved Such That it is Less Likely for Accidents to Happen Today?

One of the informants from NTNUT stated that "to have a good management system is important". This is related to safety, especially in very complex organizations. However, operational models, the organization, and its structure can also be a weaknesses. This shows the importance of looking upon the organization as a whole, since there are many factors affecting one single incident. There must be a connection between structure, cooperation, and the management system. In addition, sufficient training must be provided.

The informant working at the Snorre A platform said that there are much more focus on safety through the management system today. Operations are more simplified, and there is a considerable focus on learning from experience. Management and leaders have put high pressure on ensuring safe operations, and making sure employees understand the importance of complying. They work after the so called A standard (Compliance and Leadership). This means that they first have to define the task in governing documentation, assess the task, evaluate, and possibly correct governing documentation if this is needed. Much of the work done is routine-based, and thereby repeated over and over again. If there are new tasks that needs to be done, they use more time to make sure the operation is done correctly, and in

accordance with governing documentation. He thinks that the management system prevailing today is great, as long as everyone complies with it. Those who do not comply with governing documentation and the management system have nothing to do at the platform. It requires much attention, and hard work to be familiar with the system, but when this has been done, it is all right to use it. Due to this, he stated that accidents have been minimized, which also includes other platforms.

The informant from NTNU said it is important for the organization to focus on being resilient. This means to lay ahead of problems that can arise. A management system can prevent accidents from happening, but it is important to see this in context, and how management is carried out. The management system must have anchorage in the organization, in addition to hold clever people, and right competence.

5.4.2 How are Barriers Secured?

The informant from the Snorre A platform said that the accident in 2004 happened because of barriers not function as it should. In addition, people working at the Snorre A land organization, as well as leaders at the platform did not evaluate risk.

Today, the PSA is heavily involved by securing that barriers work as they should. Regulations are the foundation for how the PSA governs. There are concrete requirements for well and drilling, and the safety-level requirements that needs to be followed and complied with. Statoil must also work according to the NORSOK standards, which also serves as requirements.

The PSA said that barriers are secured through the management system. There are requirements for everything; the management system, management regulations, and requirements for activity and organization. As the PSA stated "It is important to avoid holes in the cheese", which is secured through barriers. In a well there are requirements of two independent barriers.

One of the informants from NTNU believes that accidents can happen regardless of these barriers being present. People do not do mistakes on purpose, and many barriers can fail. There are different scales of accidents, both large and smaller ones. However, a good framework, and evident leadership have a major influence.

5.4.3 How Should Leaders Train the Employees at Snorre A to Secure That the Organization Use Best Practice (Management System) Versus What They Did Before?

The informant from Snorre A said that Saga and Hydro were more concerned about profits, and did not think so much about maintenance at the Snorre A platform. Statoil took over a "decayed nest", and became the responsible company when the accident happened. Many things were not how it was supposed to be at that time.

The informants from the PSA said that there is a higher focus on doing things in practice today. Especially regarding the planning process. Now, there is a group in every organizational segment that deals with planning. The involved also get training on how to plan, and how to interact. When projects are executed the right experts are involved, as well as leaders on the right level. This has been an evident improvement in the later years.

At the platform, the informant said there are a lot of training and exercises every time they are back at the platform. This is for example through mustering in lifeboats. There are requirements of how fast procedures must be done. Overall, there have only been few alarms, where they have done this, in addition to the required mustering per trip. However, if something happen, they have to report it in Synergi. This system provides possibilities to share knowledge and, and to search for other relevant things, trends, and the like.

The land Chief at Snorre A commented that training is provided continuously through their training center on safety critical processes, in addition to the departments. Several programs for employees using best practice have been carried out. One of the informants from NTNU mentioned some of these; the Colleague Program from 2006, and the campaign on falling objects. There were much attention drawn to these; presentation were held, and leaders came around in the company to secure compliance.

5.4.4 Have Operations Become Safer?

There are different external conditions for Statoil today, than what was instance in 2004. Currently, there is more activity, more oil-rigs, more national- and international companies, and a different approach of getting the right competence.

The head of process drilling is of the opinion that things are continuously improving, and going towards the better. The informant from NTNU also claimed that the general picture is that safety has gotten better. The HSE requirements are more strict. Also, every incident and accident are reported through Synergi. These are measured, in addition to many systems trying to prevent accidents and breakdowns from happening.

Computer systems are better and more powerful, and have a greater degree of ability to follow up activities. The informant from the Snorre A platform also asserted that technology is much better today. This includes for example transfer of knowledge, reporting of accidents, vibration-measurement, and the like. These things were not much used before. In 2004, machines and tools were used until it did not work anymore. Today, there is more knowledge, as well as sensors giving indication of replacement a long time before it actually is needed. These sensors monitor the processes, control that everything is done correctly, and that technical equipment is in its right shape.

The PSA does not expect a risk level of zero, since there always will be some risk in an industry like this. Trends show that the number of accidents is fluctuating. If one compare for example the level 30 years ago, there is a lower degree of accidents. A fact is that accidents are repeated, meaning they often have the same underlying consequences. This was true for the Gullfaks C accident, and the Macondo accident.

Statoil has had several change projects since 2004. The company has since then also merged with Hydro. Change puts a different focus to management, and do often lead to unwanted, and unexpected consequences. There have been both internal and external changes, which affects the company and safety aspects. However, there is now focus on harmonization and standardization, and having the same operational model throughout the company.

5.5 Aspects of the Future

5.5.1 Why Are So Many Accidents Still Happening?

The informant from the Snorre A installation said that there are still many accidents today. However, there are more oilrigs, more people, and thereby many small accidents happening.

Sometimes, and unfortunately also major ones. However, he feels safe when working at the oil platforms. *"You just have to trust others doing the right things"*.

The head of process drilling said that *"It is likely, or not unlikely that accidents will happen again"*. Statoil works continuously to prevent accidents from happening. It becomes important to follow through with every technical error that happens. Also, he means that as long as one depends on human for operations to be safe, there will always be a probability of something happening again. There are many barriers to provide accidents from not happening. Nevertheless, many barriers can be forgotten, as well as someone putting wrong data in the systems. He said that currently, they try to make technology with the intention to avoid human interaction as little as possible. With all these new developments and innovations, it becomes important to make sure that these will not introduce something new and dangerous. However, people are for the most part needed to control these systems. He often experiences coming with new equipment, and employees not understanding the technology behind it when it is implemented. Introductory courses are always offered, but some may not pay so much attention, and that can lead to mistakes being done. The informant from NTNU also mentioned this. It is often stated that human are the reason for accidents happening. Their actions are affected by choices, individual baggage, decisions, and how the work-day is carried out. However, individuals are always in a bigger context. This means that it is not just their actions or mistakes that affects why accidents are happening. Therefore, it can be difficult to find out what are human or technological mistakes.

5.5.2 Where to Go from Here?

The PSA said that in Norway, there are other systems and regulations than in for example the USA. Still, there are many similarities between accidents happening in Norway and in the USA. This is visible through the Snorre A accident, Gullfaks C accident, and the Macondo accident.

Currently, the petroleum industry is characterized by high activity. Also, there is a focus on efficiency. Therefore, it becomes important that those setting premises have an understanding of this – for example those who manage budgets and time. These must also have the sufficient knowledge in the planning phase, and when carrying out operations. It is also important to have good parameters and frames from management and through the management system.

The PSA asserted that there must be high focus on getting the right competence, and sufficient capacity in the future. Statoil cannot just implement new things, for example governing documentation, without training people. This will be especially important with the increased activity in the industry. It is a high-risk business, and it becomes important to have a continuous focus on measuring, and managing and controlling risk. This is especially vital within HSE.

An informant from NTNU is of the opinion that Statoil is still characterized as a bureaucratic organization. There have been many changes since 2004, for example a new operating model, and standardization of work process. Nevertheless, he believes that this is wrong, because the organization gets weaker when it comes to professions. The standardization, and harmonization of activities can be advantageous in some situations, however, every platform is different, and one loses competence in each profession.

Another of the informants from NTNU said that it is currently an increasing belief in measuring everything, and using key performance indicators (KPI) in every situation. This is not always suitable, since not everything can be measured by KPIs. Hence, there must be an emphasis to shift focus from only using these, and to rather use indirect tools. In this matter, it becomes important put aside sufficient time, maturation, and revision. Actions must be repeated and concretized, as well as establishing a consciousness throughout the company.

6 Discussion

The discussion chapter will use the results from the interviews presented in chapter 5, together with findings from secondary sources, and theories deduced in chapter 2. The discussion has its foundation in the four questions presented in chapter 1, structured in resemblance as the preceding chapter.

The research question in this thesis is whether Statoil's management system is sufficient to avoid potential major accidents from happening at the Snorre A platform. Therefore, it becomes important to find out if the organization has implemented the requirements from the PSA thoroughly in the management system, and provided sufficient changes to secure safe operations. Also, to find out to what extent learning from the accident has led to changes in the management system, through transferring of knowledge and experience.

6.1 Has Statoil Managed to Comply with the Requirements Imposed by the Petroleum Safety Authority Norway after the Snorre A Accident?

6.1.1 The Implementation of Requirements by the Petroleum Safety Authority Norway

As the findings from the interview with the PSA suggest, Statoil has worked hard to implement the initiatives to close the variances found by the PSA. Statoil and the PSA had frequent meetings where they tried to close these variances best way possible. As stated by the PSA, Statoil struggled to find the direct effect these initiatives had on the company. This is because many initiatives affected each other, as well as some leading to unintentionally competing goal conflicts, and thereby causing negative effects. This was found in the PSA's supervision of Statoil in the period February - June in 2007. The PSA supervised Statoil to examine how the company ensured that the initiatives were followed through. This included improvement areas and if the essential initiatives provided had desired effects through HSE levels, and thereby improving safety (PSA, 2007).

The PSA (2007) stated that Statoil's new structure seemed thought-through, and perceived as having an evident reformation. However, they identified a few deviations. First, the established processes in Statoil, to secure the follow-up activities, did not ensure the requirements in the regulations. Second, inadequate systematics of Statoil's management

system, to secure its functionalism, were found. Third, the company had not fully established and complied with HSE routines. Eventually, sufficient tools to measure how the implemented initiatives contributed to the desired effect in the company were not available.

Nevertheless, attempts of measuring the impacts have been done by Studio Apertura/NTNU Samfunnsforskning, in cooperation with an internal project group at Statoil. They found significant improvements in many areas regarding safety. Including that the Snorre A organization has been supplied with new resources, gotten well integrated in the Statoil organization, and improved the access of competence and experience from Statoil. In addition, there were improvements regarding collaboration, and communication between off- and onshore installations at Snorre A. The technical condition has also been improved, which gives better opportunities for systematic. and planned work. The governing documentation has been simplified and reduced, and there is more time to consider conflicts between safety and progress (Schiefloe et. al, 2007).

Schiefloe, et al., (2007) also found areas that needed more considering. This was, among other factors, the need for simplification of utilizing systems and tools for registration, identification of risk, and risk-analysis. The new management system ARIS ensures this in a better way than DocMap and APOS did.

6.1.2 Tiredness of Initiatives

Several of the informants in the IRIS (2011) report say that there are too many initiatives after an accident in Statoil. It is hard to relate to the great quantity of measures. It is easy to propose initiatives, but harder to implement them. The amount of measures can, according to the informants, be the great respect Statoil has towards the PSA, and that Statoil often get too eager to improve.

The second challenge with the initiatives, in addition to being many, is that they do not necessary connect. One informant from the IRIS (2011) report asserted that the initiatives often compete, since they come from departments with different interests. Most of those talking about the initiative's focus, see most benefit to those directly tied to the area which needs improvement, and that possible learning has its basis in concrete areas of improvement adjusted to the units. Among other factors, many refer to the Colleague program as a positive initiative, however that it needs adjustment to fit the different parts of the organization.

6.2 What Changes Have Been Made in Statoil's Management System since 2004?

Statoil's management system has been through many changes since 2004. It was already through a process of change when the Snorre A accident happened. This was a desire from employees, but also through requirements from the PSA, national and international requirements, as well as other changes in the environment.

When the Snorre A accident happened, the management system was characterized by very complex procedures. The operations were document oriented, and assignments were either too little or too much defined. It was also a culture of doing tasks in a way that the prevailing research communities thought was right. However, there are a few deviations found in the IRIS (2011) report that varies from what is stated in the management system, and provides information to the discussion beyond what was found in the interviews. This will be discussed based on the pentagon model presented in chapter 2.

6.2.1 Formal Structure

In 2007, Statoil and Hydro merged. Accordingly, there were a full integration of activities, resources and governing documentation. Every employee got new positions, including changed tasks and roles. As part of the integration process, Statoil's system for governing documentation DocMap was copied in Hydro's corresponding system APOS. The intention was to simplify operations, however, the result was increased complexity. This was visible through too many documents, and a challenge of dividing between processes, requirements and methods (IRIS, 2011).

Statoil's management system has gone from using DocMap, via APOS, and now to their new system ARIS. The development of ARIS has been a comprehensive project to make it more understandable. This system is more simplified, and has easier search monitors. There has also been an evident clean up in governing documentation. Hence, the system has gone from being document- to process oriented.

Also, a focus on using systems in all processes carried out. Since Statoil operates in the United States, and a part of the New York Stock exchange, the company has to comply with the SOX requirements. These regulations demand that every decision and process in the

company must be traceable. This has also lead to the management system being developed accordingly. This became evident in one of the interviews from a researcher from NTNU. There are definite processes which the employee must follow when work is carried out. This can also be one of the reasons why Statoil have gone from being document oriented to process oriented (IRIS, 2011).

6.2.1.1 Governing Documentation

In the Statoil book, it is stated that governing documentation should secure standardization, and use of best practice across the company. Often, when incidents happen, attention is drawn towards adding changes to prevent them from happening again. What often happens, is that requirements and specifications are added, which leads to more complexity.

However, the IRIS report was carried out in 2011, and changes have happened since then. There have been a reduction of governing documentation of 40 per cent, which complies with wishes in the organization. From the interviews, especially from the informant working at the Snorre A platform, there were opinions of the governing documentation being strongly improved

6.2.1.2 Synergi

In spite of knowledge throughout the company of Synergi, IRIS (2011) found that the use, and satisfaction with this system is limited. Of those having knowledge of the system, Synergi is not much used. A reason for this is a perception of Synergi as being messy, and hard to navigate through. Also, from this report a tendency of documenting own experiences to a larger extent than using others' experiences was visible. Further, a tendency of some not using the system in spite of seeing the information as useful were found. This can be explained by factors as little time and difficulties of finding the right information in the system.

From the interviews carried out in this thesis, it seems as Synergi is a well known tool which is much used. At the Snorre A platform, they report every incident happening in this system. In addition, if there are any questions regarding certain activities, Synergi is used. However, the employee from the Snorre A platform stated that it can be complicated to use at first, but when sufficient time have been employed to understand it, it is a good system.

6.2.1.3 Process Owners

Process-owner's role is about intercepting best practice and experiences, and to incorporate these into global work-processes. Therefore, they have a central responsibility with ARIS. It is obvious that the work process based management system, and the functional-requirements

are very central at Statoil. IRIS's (2011) findings still show that the process owners are "too far away", as in lack of knowledge and understanding of how they practice the operations in the organizations. Their findings also show that process-owners behave and think after a rule-based action logic, while those working out in the organization have a more task-based action logic.

In the Statoil-book, five organizational principles are listed. These are supposed to support a "well-defined and simple organizational design that has flexibility to handle changes in the business and its surroundings". Many of IRIS's findings prove that there is not sufficient conformity between the content and practice of these organizational principles.

6.2.1.4 Compliance and Leadership

The updated management system ARIS simplifies compliance. This is since project evaluation "selected themes" will cover compliance with the requirements. IRIS (2011) found that best practice is assessed more often, and has gotten broader sharing. There are more clear risk-evaluation processes and methods, and a clear methodology of links, barriers, and logs on change, action and decision-making. This was also found through the results presented in chapter 5. As one of the informants from the Snorre A platform stated: *"workers not complying with the management control system have nothing to do at the platform."*

6.2.2 Culture

To deal with the culture problem, rotation of personnel on the various platforms have been made. As stated from one of the informants working at Statoil, leaders are vital in the process of building a good safety culture. They must ensure that everyone working at the installation comply with the regulations for the various operations. As the PSA said: "today, there is a clear plan of action". The A standard (Compliance and Leadership) ensures that a risk evaluation is made before tasks are initiated.

One of the informants from Snorre A asserted that they have sufficient training and exercises every time they are back at the platform. In addition, there have also been sufficient programs and training from management, for example through the Colleague Program and the campaign on falling objects.

The management system requires everyone to comply with requirements and governing documentation when operations are performed. The employees do not have the freedom to solve problems themselves anymore. In addition, they have pre-work meetings and stop and evaluate if they face new situations.

Generally, there are major changes in the safety culture since 2004. It is a different way of thinking; including a more developed HSE mindset, higher focus on the behavior of the employee, and compliance with the management control system.

6.2.3 Interaction

There is seen much better cooperation off- and onshore, in addition to more robust planning processes, involvement of the platform organization in planning, as well as more training of management. The Snorre A organization have also been integrated in Statoil.

6.2.4 Relations Network

Statoil has close collaboration with their contractors and partners to ensure safe operations. This is also emphasized in the Statoil Book. An interesting finding in the IRIS (2011) report is that there is a difference between employees and contractors in use of the various parts of the management system in Statoil. The contractors use others' experience to a greater extent, than those employed at Statoil. An explanation to this can be that contractors float between different organizations, and are used to adjusting to new environments. This require an ability to seek new knowledge, talking to other people, and participating in informal learning-environments. Permanently employed people are more naturally tied to fixed and formal routines, and management systems.

Statoil does also have close relations to the PSA, not in form of collaboration, however, through a good dialogue to secure safe operations on the Norwegian continental shelf.

6.2.5 Technology

There has been an evident development in technology since 2004. The head of process drilling said in the interview that technology is continuously improving towards the better. The informant from the Snorre A platform said that systems are today telling when something needs replacement, in difference to before when they used these until it was broken. He also assured that today's technology ensures better information and measures at the platform.

However, many of the informants from the IRIS (2011) report indicate technology as a challenge. New technology is implemented through a standardization mindset, however

creates problems since each platform demand different technological solutions. A question asked by IRIS (2011) is therefore how these innovations affect risk and safety in complex technological systems. The oil industry exists of modern technological systems that are constantly exposed of requirements of cost-effective changes, adaptation and adjustments.

Technological systems are today characterized by mutual dependence, and tight coupling between the components. The actors in the system have a desire of increasing the innovation ability, to lower costs, and to increase the robustness regarding accidents. High development in technology, and increased robustness is often a incompatible dimensions. Mutual dependence and tight coupling, contributes to small changes in the system being transmitted to the rest of the system. Continuous innovation- and technological change processes will thus create latent conditions in the system. Consequently, many small incremental innovations will increase the risk in the system (IRIS, 2011).

Change in one element of the system requires changes and modifications in a series of other elements at the same time. The problem is that there are neither resources, nor competence, or systems with sufficient overview to complete the necessary adjustments. IRIS (2011) found that many employees have reported about systems being too complex, and that knowledge about it is to poor and is not always used in the right way. These responses make visible how new technology, organizational learning, and adaptation constitutes to vulnerabilities with the system. Incremental changes will immediately require new education, training and quick reorganizations. If this does not take place, innovation and use of new technology will lead to increased risk.

6.3 To What Extent Has Learning from the Snorre A Accident Led to Changes in the Management System?

Learning is crucial when it comes to preventing other accidents from happening. Learning from the Snorre A accident, as well as other accidents, have led to a need for change in Statoil's management system.

6.3.1 Sharing of Experience and Knowledge

The Snorre A accident led to a process of understanding what was absent in the management system to secure safe operations. Later, there have been subsequent updates to establish better

solutions to handle similar accidents in the future. This is been seen through all parts of the pentagon model structuring the management system in this thesis; formal structure, culture, interaction, relations network and technology. This is also what is called single loop learning (Kaufmann and Kaufmann, 1996).

Experience and knowledge obtained after the Snorre A accident are vital contributors of prevention of other accidents if used correctly. This experience is shared through the different systems available in the management system, and is emphasized through Statoil's "Ambition to Action". An objective is that information must be open, and available for everyone to promote sharing of knowledge and ensure best practice in the entire organization. Relative KPIs in Ambition to Action are recommended as a method to stimulate learning from units that are successful both within and outside the company. The many systems for transfer of knowledge in Statoil, including Synergi, were not used sufficiently by the employees at Snorre A, at the time when the accident happened. This was since it was regarded as difficult and bothersome. There have been requirements of simplifying the management system. Through the interviews, it was revealed that this has been much more easy to use. It has also become easier for employees to understand governing documentation. This helps transferring of competence and knowledge, and make it accessible for all parts of the organization. Through surveys carried out by IRIS (2011), it was also evident that employees have a relative good knowledge of most of the systems, in relation to what was the case in 2004.

However, some say that often, sharing of knowledge and experience only "possibly" gets updated in governing documentation. Others, on the other hand, are tired over too many initiatives being punched into governing documentation, implying that the management system gets heterogeneous, control based and not suitable to use (IRIS,2011).

6.3.2 Difficulties of Learning

Comprehensive work has been made to communicate the experiences from the Snorre A accident to other environments throughout Statoil. However, several incidents, including the Gullfaks C accident is proof of this not being sufficiently integrated.

Many aspects are influencing Statoil's ability to learn. Statoil is a large company, with many different employees, varying geographical installations and organizations. This makes it more

difficult for the company to transfer knowledge and learning. A reason for this may also be that when initiatives are implemented, it is not certain that everyone understands it.

Lack of learning was seen after the accident at another Statoil platform, Gullfaks C in 2010, due to goal-conflicts. Many of the measures after Snorre A were individually good measures; they had a broad coverage and touched upon many important areas, and contributed to closing variances. However, one of the main problems were that the methods used to implement an initiative prevented achievement of goals in other areas. A focus on planning and risk evaluation contributed to more detailed work processes and more bureaucracy, whereas other initiatives were carried out to simplify governing documentation and reduce bureaucracy. In addition, a comprehensive focus on the initiatives and closing variances came at the expense of learning after the actual incident (IRIS, 2011).

6.4 Does the Current Management System Ensure Safety?

As found from the results in chapter 5, there is a completely different way of thinking now than in 2004. This is demonstrated through a higher management focus, and standardization of procedures. Also, it was found that there is a higher focus on behavior and compliance to secure safety in operations. This can be related to the behavior-based safety perspective, which says that employees often are reason for accidents happening, and that training in the management system is the best way to learn from mistakes.

A thorough comprehension found by Schiefloe, et al. (2007) is also a higher focus on safety through the management system, both at Snorre A, and in Statoil generally. This is supported by the majority of the organization, through general safety being ensured in every operation. Firstly, this has become evident in an increased attention of current problems regarding well integrity. Secondly, a general awareness regarding the need to prioritize safety, and to take the time and costs necessary have been visible. This is demonstrated by clear signals from corporate management and DPN. Eventually, there are more resilient planning and emphasize placed on following every regulation in governing documentation.

It was visible through the interviews that the increase in safety can be, among other factors, because of Statoil's clear plan of action, in addition to a higher focus on major accidents. The

people working at the platform are in addition more restrained by requirements, and following governing documentation today. It was also mentioned that it is more time available to evaluate tasks, and to stop the operation if something is not right.

Table 1 show the safety development at Snorre A from Schiefloe, et al.'s (2007) work.

Every situation taken into consideration: "I believe that Snorre A is operated in a more secure manner now than before the Snorre A accident" (Answers from employees at Snorre)									
Extremely disagree									Extremely Agree
1	2	3	4	5	6	7	8	9	10
1.1 %	0.8 %	3.0 %	2.3 %	3.8 %	12.5 %	23.9 %	19.3 %	13.3 %	20.1 %

Table 1: Safety Development at Snorre A

(translated from Norwegian. Source: Schiefloe et al, 2007)

Many of the informants said in this relation that the Colleague-program, and the campaign against falling objects have contributed additional improvement of safety at Snorre A. This was also stated by one of the informants from the interviews. Aspects of the Colleague program emphasized by employees, is an increased consciousness of safety in general, and that everyone participating has made it more legitimate to care, and to tell if other colleagues are behaving in a way that put themselves or others at danger (Schiefloe, et al., 2007). The total safety effects can be understood as an interaction of several factors as showed in Figure 6:

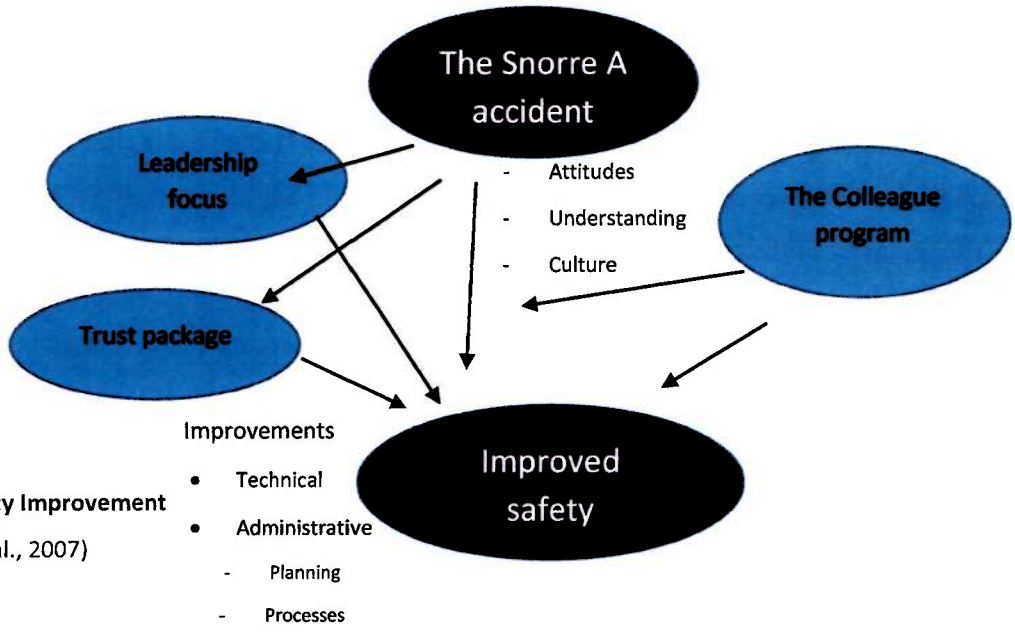

Figure 6: Safety Improvement

(Schiefloe, et al., 2007)

Schiefloe, et al. (2007) found that Snorre A operates in a more secure manner than before 2004. The cause is a general strengthening of the organizational safety barriers. A division was made between four groups of organizational safety barriers, as shown in Figure 7. Formal mechanisms are those regulated through rules, license for certification, governing documentation and formalized procedures for planning, decision-making and work performance. Simply, one can put these in groups of mechanisms of doing the right things, and mechanisms to ensure quality control. This indicates good planning and participation from management to develop a good management system that employees use in their daily operations.

Informal mechanisms are the safety critical behavior of employees. Critical aspects are sharing of experience and knowledge, as well as co-workers controlling each other by vigilance and caring. It becomes important to focus on creating a good network and culture within the organization. This is done by quality control from the organization through different programs, in addition to focus on continuous rotation of personnel and integration (Schiefloe, et al., 2007).

	Formal mechanisms	**Informal mechanisms**
Doing the right things	• Training • Governing documentation - Improvements	• Development of network • Rotation of personnel • Integration in Statoil
Quality control	• Management involvement • Planning and control • Participation	• The Colleague program - Caring - Legitimacy

Figure 7: Formal and informal mechanisms

(translated from Norwegian to English. Schiefloe, et al., 2007)

These explanatory factors can be summarized in the analytical Pentagon model. There is a positive development along all dimensions, which is summarized in the Figure 8 below:

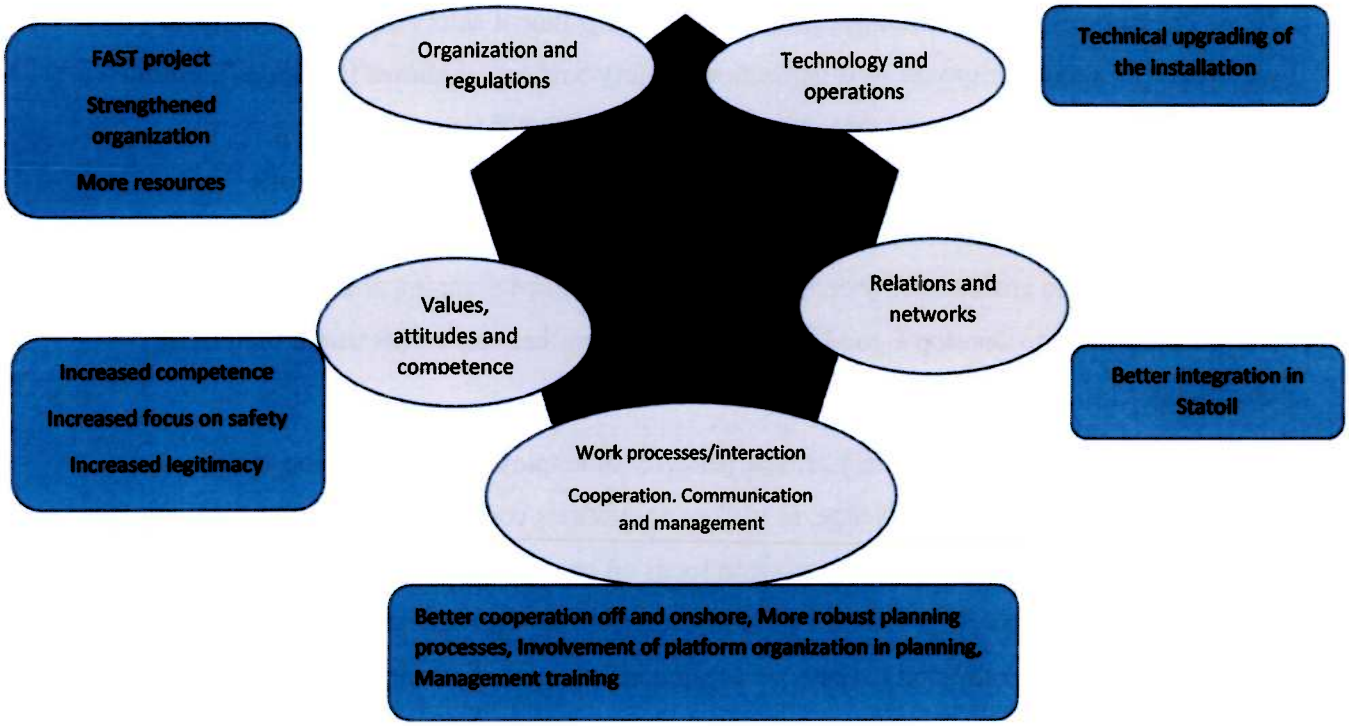

Figure 8: Safety Critical Behavior

(translated from Norwegian to English. Source Schiefloe, et al., 2007)

(FAST= Improvement of governing documentation and monitoring)

Even though the management system is to ensure safe operations, and prevent accidents from happening, it becomes important that the employees complies with this system. If people do not use the management system and the governing documentation when performing activities, this will increase the risk in the company. Therefore, the PSA (2010a) emphasizes different aspects affecting safety critical behavior, and a focus on evident HSE objectives for change. The work environment, and organizational risk contributors must be emphasized thoroughly as technical contributors. The actors must utilize own methods of risk evaluation, and interests must be acknowledged and handled through planned cooperation.

6.5 Potential Major Accidents in the Future

There are many viewpoints of why accidents happen, and whether organizations are able to prevent them from happening. Some of these were discussed in chapter two, including high reliability theory, normal accident theory, and the resilient engineering perspective.

6.5.1 Why Do Potential Major Accidents Still Happen?

The PSA has employed many resources in recent years to reduce numbers of incidents, and to improve the safety-level at the Norwegian continental shelf. The annual report on the project "Risk level on Norwegian Continental Shelf" showed positive trends in some areas, but no changes worth mentioning on the joint risk-level. Statoil has in this period suffered many incidents with considerable potential (PSA, 2007).

In the interviews, it was evident that an explanation for accidents still happening, can be the changing external conditions in this industry. Both the informant from the Snorre A platform and the PSA confirmed this. This leads to Statoil dealing with many unexpected dangers and challenges. Because of this, the PSA said it is hard to assure that accidents will not happen.

Various opinions of accidents being preventable or not, was visible in the interviews. Both the PSA, and the head of process drilling, said that a good framework must be available for the company to carry out safe operations. Nevertheless, the PSA does not expect a risk level of zero, nor does the head of process drilling. The head of process drilling said that with so many employees working at Statoil, it is difficult to ensure that no mistakes happen. These statements show signs of both normal accident theory and high reliability theory. Statoil, on the other hand, is explicit by saying that every accident can be prevented. This implies that with use of intelligent organizational design, sufficient recruitment, socializing, and training of personnel, error rates can be reduced. Also, an emphasis exists on the need for sufficient barriers.

However, in addition to creating a good framework, all the informants, and especially the PSA, emphasized the need for competence and resources for preventing accidents. One of the informants from NTNU said that this is achievable through creating a resilient organization. Since this perspective builds upon many theories, it can be discussed whether this is a more developed mindset of understanding how to avoid potential major accidents.

The optimal situation for Statoil to prevent accidents could be to develop robust characteristics, and thereby foresee every potential major accident. Statoil does possess robust organizational characteristics mentioned, as knowledge, competence, resources, and time. In addition, the company shows signs of reacting to most errors and disturbances through high developed technology and good monitoring-systems. However, signs are visible of learning difficulties, as well as the ability to foresee every accident. Therefore, Statoil lacks some of

the important robust qualities. A question to be asked is whether these remaining qualities are possible to achieve.

7 Conclusion

This chapter presents the master's thesis conclusion. The conclusion is based upon existing theory presented in chapter two, in addition to the results and discussion presented in chapter five and six. The research is a qualitative case study, and therefore only intended to contribute to an increased understanding of the subject, as well as a supplement to further research.

7.1 Is the Current Management System at Statoil Sufficient to Prevent Potential Major Accidents from Happening at the Snorre A Platform?

The research question in this master's thesis is if the current management system at Statoil is sufficient to prevent potential major accidents from happening at the Snorre A platform. To provide guidance in the search for solutions, four question have served as a foundation throughout the thesis. These are whether Statoil has managed to comply with the requirements imposed by the PSA after the accident, to what extent learning from the accident has led to changes in the management system, what changes have been made since 2004, and if the current management system ensures safety.

Statoil has corrected all the requirements imposed by the PSA after the Snorre A accident. There were many infirmities detected regarding the management system, and Statoil has employed many resources to improve. In addition, other incidents and requirements from employees have also led to changes being pushed forward.

Since 2004, changes have been made in all parts of the pentagon model, including formal structure, culture, interaction, relations and network, and technology. This includes, among other factors, a simplification of governing documentation and systems, standardization and harmonization of procedures, going from being document to process oriented, as well as a higher focus on compliance. In addition, technology has improved, rotation of personnel have been made, and the Snorre A organization is completely integrated in Statoil. This contributes to a higher level of safety both at Snorre A and in Statoil today. In addition, there is more focus on preventing major accidents at Statoil.

Even though learning has occurred through public reactions and own experiences, the company does show lack of compliance with the changes made throughout the different divisions. This is visible through the Gullfaks C accident, where many of the same underlying

causes as the Snorre A accident were found. This implies that it is not always a direct coupling between experience and learning in organizations.

Even though there have been significant improvements in Statoil's management system since 2004, the question becomes if these are sufficient, and whether the improvements can prevent a major potential accident from happening at the Snorre A platform again. The results show that there are varying viewpoints on this matter. These are similar to both normal accidents theory, high reliability theory, and the resilient engineering perspective.

Statoil has developed a good framework through the management system, and provides training and courses when changes are made. However, the company has learning difficulties and does not possess the ability to foresee every accident happening. The company does therefore lack some of the important qualities to develop a resilient organization.

The Snorre A platform has become one of the better installations after the accident. However, the PSA, nor most of the other informants, do not expect a risk level of zero owing to the complexity prevailing in this industry. Therefore, it becomes difficult to say if a management system can prevent potential major accidents from happening. As the land chief from Snorre A stated:

"The management system is under continuous development; however, any accident can challenge that in the future."

7.2 Further Research

There are a few aspects found in this master's thesis that can be interesting to investigate further. This is especially regarding the many changes in Statoil's management system. There can be unforeseen consequences leading to both similar, as well as other accidents happening. Further investigation can take its basis in the following questions:

1. Because of every platform's distinct characteristics, can standardization of procedures lead to an increased probability of accidents happening?
2. What effect have rotation of personnel on competence and knowledge?
3. What factors do Statoil neglect, since many of the accidents happening have the same underlying consequences?

4. Which measures can be used to improve the ability to lay ahead of potential major accidents?
5. How can Statoil increase learning throughout the company after potential major accidents?

In addition to these questions, it will be interesting to investigate whether it is possible for Statoil to obtain the remaining characteristics which defines a resilient organization. Also, if it is possible for these to be persistent, and thereby endure, in spite of the many changes prevailing in the petroleum industry. When doing a more in-depth study of this, an emphasis must be on including more aspects regarding Statoil's ability to learn, than what is mentioned in this thesis. This also includes an investigation of other internal and external factors affecting potential major accidents.

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