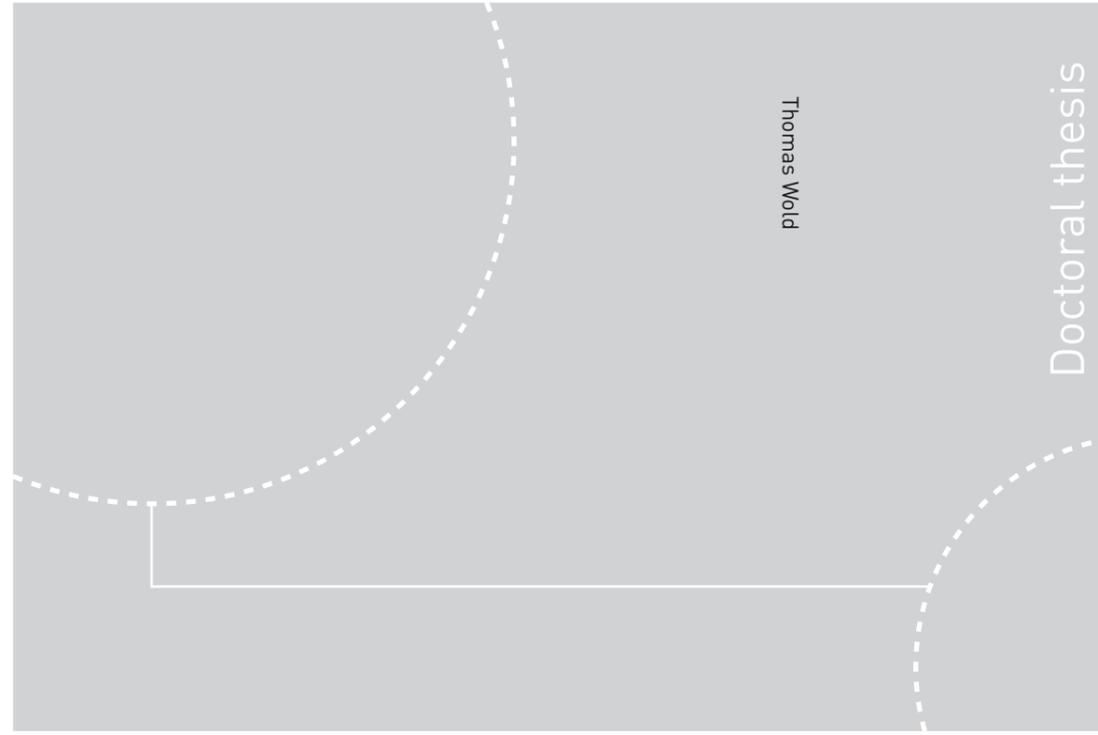


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Thomas Wold

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NTNU
Norwegian University of
Science and Technology
Thesis for the Degree of
Philosophiae Doctor
Faculty of Social Sciences and Technology
Management
Department of Psychology

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Trondheim, November 2016

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Summary

In this dissertation the use of Safety Management Systems and governing documentation in high-risk industries is examined through a literature review and qualitative interviews with executives and operators at two different companies involved in gas and petroleum production on the Norwegian shelf. The aim is to discuss the potential for improvements in the development of Safety Management Systems and in staff training, by understanding the Safety Management System as a communication system.

The following four research questions will be discussed:

- 1: How is the Safety Management System defined in the safety literature?
- 2: How is the Safety Management System used in a petroleum producing company?
- 3: How can end user involvement improve the development and use of procedures and the Safety Management System?
- 4: What kind of training in the use of procedures and the Safety Management System are the workers in two different companies given? How can the training be improved?

The empirical data was collected by conducting qualitative in-depth interviews with 27 staff members from two different companies in the Norwegian gas and petroleum producing sector. Qualitative interviews with open-ended questions were chosen to gain a deeper understanding of how the executives and operators understood the Safety Management System and the procedures.

Safety Management Systems are here defined as IT-based systems whose purpose is to code and share good practices, create corporate knowledge directories and to create knowledge networks for the organisation. Safety Management Systems and the procedures can be regarded as a form of communication. These systems were designed at an executive level in the organisation and are being communicated to the lower levels in the organisation's hierarchy. There is no guarantee that the employees will perceive, understand and interpret the procedures and the Safety Management System as intended by the management.

Executives in this study generally regarded Safety Management Systems as important tools for all work in hazardous environments, while the operators were not always enthusiastic. While executives perceived the management system as a fundamental tool for safe conduct, the attitude among the workers was that they could do their job properly without the Safety Management System. The workers

acknowledged the need for safety measures, but they did not see how the Safety Management System was supposed to ensure safety.

The informants who were able to say something about the purpose of the Safety Management System had a much better use of it than those who could not. The group with good use saw the procedures as helpful, and as a result of industrial experience accumulated over many years. The informants who did not have a good use of the procedures saw their own experience as more important for safety, and thought that the Safety Management System was more important for the managers than the operators. They could only give vague descriptions of the Safety Management System, thought it was difficult to use, and would rather just go out and do the job. They acknowledged the need for safety measures, but could not see how the Safety Management System was supposed to ensure safety.

Several of the challenges with using the Safety Management System in these two companies were related to communication and to the social and organisational context, including how the workers relate to computers, information overload, difficulties in dealing with highly detailed procedures, the development of informal procedures, the workers' ideals of professionalism, and how to ensure good two-way communication.

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1 Introduction

The purpose of this dissertation is to investigate how an information technology (IT)-based Safety Management System is being used in two different companies in the gas and petroleum industry, and to discuss the potential for improvements in the development of Safety Management Systems and staff training, by analysing the Safety Management System as a communication system. Work procedures, rules and checklists are usually designed and organised at an executive level in the organisation and are then communicated to the lower levels in the organisational hierarchy. How is this information perceived and understood at the receiving end?

In professional organisations the focus has often been on providing new tools, with less focus on how to get the staff to change their working patterns in accordance with these new tools (Heimplaetzer & Busch, 2007). Much effort has been made to standardise procedures and to streamline human action in order to decrease risk and increase productivity in the gas and petroleum industry, as well as in other industries operating in a hazardous environment. These procedures are usually organised in various forms of IT-based management systems, where the purpose is to create corporate knowledge directories with guidelines for good practice in order to ensure safety and increase production results. In both the safety research and in the industries these systems are given different terms. In this thesis, Safety Management System is the preferred term, which will be further explained in chapter 2.

The various Safety Management Systems differ in the way they are constructed and the way they are being utilised. In some organisations they mainly contain safety procedures for risky operations or work at the sharp end, while others have prescribed procedures for all tasks in the organisations, including administrative tasks. In the two industrial companies researched for this project, the latter is the case, as the management systems studied here contain procedures for all tasks at all levels in the companies. They contain procedures and checklists for tasks at the sharp

end, for ordering new equipment, for administrative tasks, for writing overtime etc. Operators and executives are expected to use the Safety Management System routinely to make sure they perform their given tasks according to official guidelines and company values. The analysis in this study focuses on the operators' use of the Safety Management System.

Although references will be made to research on the use of computer based procedures in other industries, the aim of this analysis is not to compare the Safety Management Systems to systems in other organisations or industries or to review guidelines from safety authorities which is outside of the scope of this thesis. Instead, this research is a case study on the use of Safety Management Systems in two organisations with particular focus on the communicational aspects.

1.1 Research questions

The central research questions in this dissertation are:

- 1:** How is Safety Management System defined in the safety literature?
- 2:** How is Safety Management System used in a petroleum producing company?
- 3:** How can end user involvement improve the development and use of procedures and the Safety Management System?
- 4:** What kind of training in the use of procedures and Safety Management System are the workers in two different companies given? How can this training be improved?

The research project has been designed using perspectives and methods from reception studies and thematic analysis. Reception theory is a media and communication theory which emphasises that any information must be interpreted by the receiver and the receiver will interpret the information according to his or her prior knowledge, values and attitudes (Hagen, 2004; Jensen & Rosengren, 1990; Morley, 1992). Originally, the focus in reception theory was audience's experience with and interpretation of mass media communication. The focus has expanded to include any mediated communication, like internet, social media, e-mail, mobile phones, text messages, online communication etc. (Hagen & Wold, 2009). Hence,

reception theory can be useful for analysing the communication in a large organisation, which heavily relies on different types of media, and often involves people with different backgrounds. According to a reception theory perspective the Safety Management System and the procedures can be regarded as a form of communication. The system was designed at an executive level in the organisation and is being communicated to the lower levels in the organisation's hierarchy. There is no guarantee that the employees will perceive, understand and interpret the procedures and the Safety Management System as intended by the management. Reception theory can easily be combined with insights from human factors, which revolves around the central importance of the user, including the communication and cognitive processes involved in using the Safety Management System, and the organisational culture (Wickens, Lee, Liu, & Becker, 2004). The use of software and media technology cannot be studied isolated from its environment. The organisational context is crucially important. The formal descriptions, procedures and standardisations should be regarded as cultural constructs, with all the ambiguities this opens up (Grote, Weichbrodt, Günter, Zala-Mezö, & Künzle, 2009).

1.2 Affiliations

This dissertation is part of the research programme called Integrated Operations for Proactive Environmental Protection (IOPEP). The project is owned by the Institute for Energy Technology (IFE) in Halden, Norway. Asgeir Drøivoldsmo at IFE is Project Manager, and Computas and the Norwegian University of Science and Technology (NTNU) are collaborators. The research has been funded by The Research Council of Norway, under the PETROMAKS- programme, grant no. 200542 and by an industrial partner, a company involved in gas and petroleum production on the Norwegian Continental Shelf. The work for this dissertation has been performed at the Centre for Safety and Human Factors, which is a part of the Department of Psychology at the Norwegian University of Science and Technology (NTNU). Associate professor Karin Laumann has been the teaching supervisor for this PhD project. The objective of the IOPEP- project is to provide knowledge and IO-based tools for monitoring and for proactive protection of the environment

potentially affected by oil and gas installations on the Norwegian Continental Shelf. This includes a focus on collaborative work processes and decision making, and how to utilise the competence that is distributed across the organisation to obtain more efficient management of and compliance with regulations and requirements.

1.3 Structure of the dissertation

As the research questions have already been presented, the next chapter will present the theories utilised. The first part is an outline of five approaches to safety and safety management: Natural Accident Theory, High Reliability Organisation, Resilience Engineering, Drift into Failure and Communication. The communicational approach to safety management is suggested as a new approach, mainly with communication perspectives taken from cognitive psychology and reception theory. The second part of the theory section will present central concepts from safety science, safety management, knowledge and organisational culture. The purpose of this section is to gather material from different sources to formulate functional definitions of these concepts. Chapter three presents a description of the informants and the Safety Management Systems used in the two companies, the methods used, the data collection process and thematic analysis, and offers a discussion of validity, reliability, transparency and reflexivity in qualitative research. The most significant findings are presented in the summaries of the research papers in chapter four, and are further elaborated in the general discussion in chapter five, together with aspects from the theory chapter. Additionally, how the five approaches to safety can be helpful when developing procedures and Safety Management Systems are discussed. Summing up and conclusions offer a revisit to the four research questions presented in the introduction, and a summary of the scientific contribution and practical implications of this study, and suggestions for further research.

2 Theory

In this thesis, safety and organisational communication is studied from a variety of academic perspectives and disciplines: psychology, social sciences, engineering, safety science, and communication studies. The communicational perspective on Safety Management Systems builds on perspectives from reception theory, cognitive psychology and human factors. The communication perspectives will be used to shed light on interpretation and adaption of procedures, ideals of professionalism, resilience, human factors and training.

Section one in this chapter will give an outline of five approaches to safety and safety management: Natural Accident Theory (NAT), High Reliability Organisations (HRO), Resilience Engineering, Drift into Failure and Communication. In section two various key concepts with importance for Safety Management Systems will be presented: safety and Safety Management Systems, governing documentation, knowledge, organisational culture and safety culture.

2.1 Approaches to safety: NAT, HRO, Resilience Engineering, Drift into Failure and Communication

There are various approaches to analyse safety management in organisations working with high risk technologies. In this segment, the following approaches will be discussed: NAT, HRO, Resilience Engineering, Drift into Failure and Communication. These approaches do not deal specifically with Safety Management Systems and procedures, but with safety in industrial organisations in general. They will be presented here to give some overall perspectives on safety. These perspectives will later be used to look more specifically into the use of Safety Management Systems and procedures, and the need for standardisation and flexibility.

2.1.1 NAT

NAT was initiated by Perrow's (1984) attempt to use his analysis of the disaster at Three Mile Island to create a more general formulation concerning industrial accidents (Weick, Sutcliffe, & Obstfeld, 1999). According to NAT, any organisation

that operates high-risk technologies will have accidents in the normal course of operation (Lekka, 2011; Perrow, 1984; Weick et al., 1999). These organisations are characterised by tight coupling and complex interaction. Tightly coupled elements in the system have a high degree of interdependence, and with complex interaction among the organisation's components the interaction becomes unpredictable or invisible. An important point in NAT is that a central organisation is needed to control systems with tight couplings, while systems with high interactive complexity must be controlled by a decentralised organisation. According to Perrow (1984), in organisations with tight coupling and interactive complexity these requirements cannot be met, and hence, accidents are inevitable (Boin & Hart, 2008; Haavik, 2014; Hopkins, 2014; Lekka, 2011; Perrow, 1984; Weick et al., 1999). NAT has been described as a technologically deterministic approach which emphasises that the technical design of the system has huge implications for safety, and that major accidents are caused by a mismatch between the properties of the technology to be controlled and the structure of the organisation responsible for controlling the technology (Grötan, Albrechtsen, Rosness, & Bjerkebaek, 2010; Haavik, 2010). There have been debates concerning the usefulness of NAT. Hopkins (2014) argued that the theory has not been useful at all when it comes to explaining the major accidents of our time. In fact, Perrow himself acknowledged that most high profile accidents in recent decades were caused by poor management, cost pressure and such, and not the inevitable result of tight coupling and complexity (Perrow, 1994). The view that accidents are inevitable is contested by researchers within HROs who have argued that accidents in complex systems are not inevitable because there are processes in place that enable high hazard organisations to effectively prevent and contain catastrophic errors (LaPorte & Consolini, 1991; Lekka, 2011).

2.1.2 HRO

The term HRO has its origin at the University of California in the 1980s, where a group of researchers at the Berkeley campus observed that the majority of safety research had been on accidents, and argued that one should widen the scope to also conduct research on organisations that are able to operate in hazardous

environments without accidents (Hopkins, 2007; Sutcliffe, 2011). Aircraft carriers, air traffic control and nuclear power plants have been typical areas for HRO research. These organisations operate in unforgiving social and political environments, their technologies are risky, and the consequences of mistakes are potentially disastrous, precluding learning through experimentation (Boin & Hart, 2008; Sutcliffe, 2011).

HROs are organisations that have an almost error-free performance despite operating with complex technology in hazardous conditions where the consequences of errors could be catastrophic (Haavik, 2014; Lekka, 2011; Rochlin, 1993; Weick et al., 1999). They operate complex and demanding technologies, and are tightly coupled in the sense that there is high interdependence among the components of the system, and sequences are rapid and difficult to interrupt (Hopkins, 2007; Lekka, 2011). There has been much debate on how to identify and define HRO. The criteria for deciding which organisations are HRO and which are not are not clearly defined, and no one knows how many HROs there are (Hopkins, 2007; La Porte, 1996). Rochlin stated that 'no truly objective measure is possible' (1993, p. 17). HROs and non-HROs can be more similar than they appear, and failure can be disastrous for all types of organisations, as demonstrated by Weick and Sutcliffe (2007). A different approach is to rather focus on the types of processes and characteristics that enhance reliability, and use this in helping organisations improve and sustain their safety performance (Lekka, 2011). This way, HROs can provide a distinctive set of processes that foster safety and effectiveness under trying conditions (Weick et al., 1999). There are five main characteristics of HROs: (1) Preoccupation with failures rather than success, (2) reluctance to simplify operations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise (Hopkins, 2014; 2007; Weick & Sutcliffe, 2001; Weick et al., 1999).

(1) HROs are wary of success as this can breed complacency, and are preoccupied with failure because errors and mishaps can function as signals that portions of the system might be vulnerable (Hopkins, 2007; Lekka, 2011; Weick et al., 1999). Because of this, it is important to create a report culture where people are prepared to report errors or near misses (Reason, 1997; Weick et al., 1999). (2) To simplify operations

means to discard some information as unimportant or irrelevant, but this information may be important to avert disasters. Therefore, HROs are reluctant to do so (Hopkins, 2007; Weick & Sutcliffe, 2001; Weick et al., 1999). (3) Sensitivity to operations means that their front line operators strive to maintain situational awareness (Hopkins, 2007). It also means that management engages with front line staff in order to obtain the bigger picture of operations (Lekka, 2011). (4) That HROs show commitment to resilience means that they are not disabled by errors or crisis, but mobilise themselves when these events occur so they are able to deal with them (Hopkins, 2007). HROs are not error free, but are able to handle errors and to learn from them (Weick & Sutcliffe, 2001). (5) Deference to expertise means that when operations are being carried out in high tempo, decisions are taken by individuals with the relevant expertise, regardless of their position within the organisation's hierarchy (Antonsen, 2009; Hopkins, 2007; Lekka, 2011; Weick et al., 1999).

Other characteristics of HROs worth mentioning include managers monitoring decisions but not intervening unless required, safety critical information being communicated through various channels, built-in redundancy and back-up systems in case of failure, and a continuous focus on training of staff in order to enhance and maintain the operators' knowledge of the complex operations in the organisation and to improve their technical competence enabling them to recognise hazards (Lekka, 2011).

2.1.3 Resilience

Resilience engineering focuses on the ability of a socio-technical system to monitor and cope with normal variability in human, technological and organisational performance, and to maintain a dynamically stable state in the presence of continuous stress and after mishaps (Grote et al., 2009; Haavik, 2014; Hollnagel, Woods & Levenson, 2006; Weick & Sutcliffe, 2001). Resilience is not only about bouncing back from errors and mishaps, but also to learn from the experience (Boin & Hart, 2008; Weick et al., 1999). Resilience involves the ability to alternate between periods of robust operation and phases of adaption and development, and to have a prepared set of responses or being able to adjust normal functioning in response to

regular disruptions and disturbances (Hollnagel et al., 2006; LeBot & Pesme, 2014). Resilience engineering is usually not described as a theory, but rather as concepts and precepts (Hollnagel et al., 2006).

Some abilities have been identified as fundamental to resilience: (1) knowing how to absorb strain and preserve functioning in spite of adversity, either by implementing a prepared set of responses or by adjusting normal procedures, (2) being able to monitor both what happens in the environment surrounding the organisation and the performance within the organisation, and in this way being able to see what may become a threat in the near future, (3) knowing how to anticipate developments, threats and opportunities further into the future, (4) being able to recover or bounce back from untoward events, and to learn and grow from previous episodes of resilient action (Hollnagel, Paries, Woods, & Wreathall, 2011; Hollnagel et al., 2006; Weick & Sutcliffe, 2007). This includes the ability to anticipate developments, threats and opportunities, their consequences, and to learn from experience. This relates to not only the ability to learn from mishaps, accidents and near-misses, but also the ability to learn from success (Boin & Hart, 2008; Hollnagel et al., 2006). In order to achieve this, one must know what to look for with regards to how people act and how the system operates. Instead of putting all emphasis on strict procedures and tight coupling, safety is rather achieved through human processes and relationships that enable the system to handle unforeseen events (Grote et al., 2009). An important ingredient in this is to achieve the right balance between standardisation and flexibility when designing the rules and procedures (Grote et al., 2009).

There are several overlaps between resilience and HROs. Hopkins (2014) criticised researchers who present resilience as something new when it is so similar to HRO. Hopkins stated that the essential features of resilience are pretty much the same as in HRO (Hopkins, 2014). Both approaches argue that an organisation can develop a safety culture, and identify principles to enable organisations to be able to bounce back from errors and to learn from them (Lekka, 2011). Further, both HRO and resilience stress the importance of a just culture where accidents and near misses are reported, management commitment, flexibility and a commitment to learn from error

(Hopkins, 2014; Lekka, 2011). Resilience and HRO have much in common, and offer principles that can be implemented by organisations to improve their reliability and safety performance (Lekka, 2011).

2.1.4 Drift into failure

According to Dekker (2011) and Rasmussen (1997), accidents usually do not emerge from single causes that trigger a series of events, but from interaction among system components that violate the safety constraints. Therefore one should look at how the system operates and organises the hazardous technology in order to identify how accidents were allowed to happen (Dekker, Hollnagel, Woods, & Cook, 2008). Only in stable surroundings can this be effectively done by using the classic approach of command-and-control (Rasmussen, 1997). Organisations operating in risky environments are not stable, but constantly deal with fast technological changes, fierce competition, changing regulatory practices and public pressure (Rasmussen, 1997). To operate hazardous technology is then a matter of keeping many interrelated components in a state of dynamic equilibrium (Dekker et al., 2008).

In all top-down rule-oriented organisations there will be many work situations that leave many degrees of freedom for the individual operator to decide how a task should be performed, or in other words, to adapt the written procedures to the immediate situation. Rules and procedures cannot foresee all local contexts and situations that may occur, and as a consequence they are practically never followed to the letter (Rasmussen, 1997). Adaptions and modifications of procedures occur all the time, and appear to be quite rational given the local context, work load and time constraints (Dekker, 2011; Rasmussen, 1997). These decisions can grow into an unreflective routine that over time leads to a systematic drift of organisational behaviour towards the boundaries of safe operation. Ultimately, this development can result in a harmful outcome (Dekker, 2011; Rasmussen, 1997).

This process of drift occurs in small steps where actions that were previously seen as a small violation of a safety constraint are being normalised. The local procedure violations or adaptions have no immediate, visible effect. They appear to be safe, and

this operational success is taken as a guarantee that small adaptations will not harm future safety (Dekker, 2011; Rasmussen, 1997). Decisions may be rational according to the local work context, but the workers in complex systems do not have complete knowledge about how their actions may have long term effects on other parts of the system (Dekker, 2011). In addition, in a complex system there is no guarantee that doing the same thing twice will lead to the same result (Dekker, 2011). According to Rasmussen, organisations should focus on making the boundaries explicit and known, and on developing coping skills at boundaries. In this way, workers can cope with the boundaries without crossing over to unsafe practice (Rasmussen, 1997).

2.1.5 Communicational aspects of safety

All four of these approaches to safety management have communicational aspects embedded in them, although not always explicitly stated, but many of the main characteristics include communication. All four approaches stress that the management should engage with front line staff in order to obtain the bigger picture of operations, and update procedures in line with the organisational knowledge base. The four approaches advocate a just culture where near misses and accidents can be reported without fear of punishment, and that all warning signals are systematically collected with open communication of the outcome of the accident investigation (Lekka, 2011). This involves a learning culture where information is communicated and shared effectively across different departments or shifts, and also across hierarchical levels within the organisation (Lekka, 2011; Petroleum Safety Authority Norway, 2004). This will inevitably involve a healthy dose of bottom up communication of bad news. Clearly, a sound communication climate is important for working towards establishing HRO and resilience principles in an organisation and to avoid drifting into failure. Communication is important for all aspects of safety in an organisation, and the Safety Management System can be seen as an attempt to systematise this communication. Safety Management Systems have often been regarded as tools, both in the safety literature and in the industry. With this perspective one runs the risk of blurring potential ambiguities. Safety Management Systems should rather be regarded as communication systems and analysed as part

of the internal communication in the organisation. This perspective opens up new possibilities to analyse why the management system and the procedures so often are perceived in different ways by different people in the organisation.

There is no real consensus on how communication should be defined, and the concept is used differently in various disciplines. Communication has been described as something impossible to not perform; one cannot not communicate (Watzlawick, Bavelas, & Jackson, 1967). Others see communication as a mere transmission of information, although this information is not necessarily received or understood as intended (Drottz-Sjöberg, 2012). The basic difference between the various definitions of communication is where they locate meaning (Krauss & Fussel, 1996). Some definitions place meaning as something inherent in the message. Other definitions put emphasis on the intended meaning from the sender of the message, while others put emphasis on the receiver of the message and regard meaning as something that occurs in the meeting between the message and the receiver (Krauss & Fussel, 1996; McQuail, 1997; Morley, 1992).

Most of the communication in a Safety Management System is one-way communication in the sense that messages are moving mainly from the upper levels of the organisational hierarchy downwards to the lower levels, though with some opportunities for two-way communication. In a broader theoretical perspective though, communication like this is never that straightforward. When communication passes through a medium, whether it is text or images, sounds or video, there is always a fundamental difference between the sender and the receiver; they are divided by time and/or space. The meaning of the message is never entirely inherent in the message itself, but comes to life in the interface between humans and technology. When the worker uses the Safety Management System he or she interprets the message according to his or her prior knowledge and experience. Using a Safety Management System is a cognitive process, so one should emphasise the cognitive characteristics of humans and how people interact with technology. Reception studies offer some interesting perspectives when analysing this communication and interpretation process.

2.1.5.1 Reception theory in organisations

Reception theory focuses on the production of messages and the reception and interpretation of those messages by an audience (Shore, 1998). The basic perspective in reception theory is that meaning is not inherent either in the message itself or the sender or receiver. Rather, meaning is seen as constructed in the interaction between the sender, the message and the receiver, and the context this interaction occurs in matters a great deal (Hagen, 2004; McQuail, 1997; Morley, 1992). Two things are particularly important here. Different people may interpret the same piece of information differently, and meaning structures constructed by the audience are not necessarily the same as the meaning structures intended by the sender (Hall, 2002; 1980; McQuail, 1997; Morley, 1992). Initially the purpose of reception studies was to analyse how people use and understand mass media in their everyday life, and has later included a focus on digital and online media like mobile phones, internet and online chat (Hagen, 2004; Hagen & Wold, 2009). Reception theory can be useful to analyse how and why different interpretations and even misunderstandings occur in an organisation where the communication relies heavily on different types of media.

In a professional organisation the management knows who the receivers are in the internal communication process, and there is (or at least should be) no doubt about what the intended meaning of the mediated message is. Even so, the management in organisations often experience that the responses and reactions from the staff indicate unexpected interpretations, or that the communication was more or less ignored (Bouwman, Hooff, Wijngaert, & Dijk, 2005). This is because many organisations tend to imagine a linear transfer model of communication, where every message is simply transferred from one level to another and understood as intended. Rather, emphasis should be on the study of the staff as interpretive communities. Mediated messages are constructed as meaningful discourses by the management. At the receiving end, the individual member of the staff will interpret the communication and accept, negotiate or reject it (Hall, 2002; 1980; McQuail 1997). This is why reception theory can provide useful perspectives when analysing the communication in an organisation and the Safety Management System as a part of

this communication. This is also in accordance with Reiman's (2011) notion that the functioning of the maintenance organisations should be evaluated holistically, taking into account the individual, social and organisational elements.

Reception theory is based on a constructivist perspective which emphasises that we can only have knowledge about the world through language. We do not literally store and retrieve everything we see and hear, but we interpret and modify. All information we receive will be interpreted according to our own values, attitudes and frames of reference, and the context in which we receive the information will also have an effect on how we interpret it. When we retrieve the information we are guided by structures of knowledge, or frames of references, where our memories about persons and episodes are gathered and organised. Sometimes we may exceed the available information in order to interpret the message in line with our existing frames of reference, or understanding of the world (Wahldahl, 2001). Reception theory rejects the linear stimulus-response model of communication which was so fundamental to earlier communication research, and emphasises the study of audience as interpretive communities (Hagen, 2004; Jensen & Rosengren, 1990; McQuail, 1997). When a message is communicated, each individual receiver must interpret the message, and will do so according to his or her prior knowledge, experience, attitude and values. Stuart Hall's encoding-decoding model has been central to theorise this interpretation process. The encoding-decoding model stipulates that communication is constructed as a meaningful discourse according to the prevailing values and attitudes in the society, or a given group of the society, particularly the values and attitudes of the producer of the communication. At the receiving end, the individual member of the audience will interpret the communication and accept, negotiate or reject it (Hall, 2002). This does not mean that any communicated message can be interpreted in any way. Messages are polysemic, i.e. they hold the potential for several different meanings, but there are structures that guide the interpretation (Hall, 2002). We can talk about a potential for meaning in the message and a potential for interpretation for the individual, which is triggered when the message is distributed through various media and is received by

the individual. The social and cultural context in which the media distributed message is received, both at the micro-context and the macro-context, is believed to be of significance regarding the interpretation and meaning production (Morley, 1992).

The meaning structure constructed by the individual is not necessarily the same as the meaning structure intended by the sender, and this has a great deal to do with the structural difference of relation and position between senders and individual receivers (Hall, 2002), or, in our case, between the different levels of the organisation. So called 'distortions' or 'misunderstandings' arise precisely from the lack of equivalence between the two sides in the communicative exchange (Hall, 2002, p. 131). In a professional organisation it is plausible to assume that there will be some asymmetry between the codes of sender and receiver. In other words, the top level of the organisation might not share the same ideas, values, attitudes and language as the lower level, or the lower level might understand and interpret these codes differently. Another factor is that the different levels of the organisation are not necessarily in perfect harmony with each other, and resentment towards the leadership can influence the communication. In some cases they can have similar interests, for instance a profitable result for the organisation is usually in everyone's interest, but there are also situations where they can have different interests, or they might have different ideas about how the mutual goal should best be achieved. People with different roles in the organisation might have different frames of reference.

2.1.5.2 Frames of references and mental schemes

Living in a given culture gives the individual a certain knowledge and experience that forms frames of reference. These frames of references are relatively stable structures. Some of these frames of reference are cultural and are more or less taken for granted by the majority of the members of a given society. Other frames of references are shared by the members of a social group, while others are more individually based. The distinction between cultural, social and individual frames of references is first and foremost an analytical one, and is an attempt to conceptualise

that some frames of references are shared by almost anyone in a given society, while others are shared only by members of a social group, and others are unique to each individual member of these group. The individual member of the audience will interpret any communicated message in light of his or her previous knowledge and experience that forms these frames of references. In an organisation it can be useful to consider how some frames of references are shared by the entire organisation, and, at the same time, how each level of the organisation might have specific frames of references which are unknown at the other levels in the organisation, and how different subcultures within the organisation operate with different frames of references.

Frames of reference are similar to the concept of mental schemes from cognitive psychology. Mental schemes are mental structures containing the individual's abstract and organised version of reality, as formed by earlier experience. Mental schemes structure all our experience, including our experience with different media discourses and genres (Wahldahl, 2001). They can be seen as semantic networks that describe a typical sequence of activities, like getting online in a computer system, shutting down a piece of industrial equipment, or dealing with a crisis at work (Wickens et al., 2004). As mental schemes have been formed by previous experience they can also be changed or modified by new experiences. The established mental structures are important for how we interpret any information and communication, but at the same time the content of the information and communication we are exposed to will have an effect on the further development of these mental schemes.

2.2 Concepts and definitions

In this section various concepts and definitions will be presented: safety, safety management systems, governing documentation, knowledge, tacit knowledge, organisational culture, safety culture and human factors. Several of these concepts are being debated in the research literature, so the purpose of this section is to sum up the main lines of the discussion and formulate functional definitions.

2.2.1 Safety

Safety is the fundamental concept that everything in this dissertation boils down to. Safety science has for the most part been concerned with risk, hazards, accidents and mishaps and the events that lead to them (Haavik, 2010; Hollnagel, 2014). Accidents are events involving an unplanned and unacceptable loss, and safety is usually seen as the absence of accidents (Aven, 2014). Safety is often defined as a condition where nothing goes wrong, for instance as ‘the freedom from accidental injury’, as stated by the U. S. Agency for Healthcare Research and Quality (Hollnagel, 2014, p. 22). Dictionary definitions of safety also focus on freedom from danger, risk, injury or loss (Aven, 2014). The same goes for the research literature where the understanding of safety is closely related to the understanding of risk as a situation where something of value is at stake and where the outcome is uncertain (Aven, 2014). Industrial accidents are traditionally seen as caused by technological as well as human error (Antonsen, 2009; Antonsen, Almklov, & Fenstad, 2008; Bjerkan, 2010; Haavik, 2010; Oltedal & Engen, 2011; Reason, 1990). A human error is when a person inadvertently or through poor judgement fails to follow a prescribed course of action (Rochlin, 1993). The traditional answer to this has been to create barriers, standardisations and procedures in order to constrain performance, but it is also being argued that such measures rely too much on an inadequate explanation of risk and accidents as a linear combination of failures and malfunction (Antonsen et al., 2008; Haavik 2010; Hollnagel, 2009).

Safety definitions focusing on the lack of accidents are not adequately stable definitions of safety to work on. Hollnagel argued that while such indirect definitions of safety makes practical sense, they leave nothing to be measured when safety is

present, only when safety is absent (Hollnagel, 2014). Safety can alternatively be defined as a dynamic non-event: the non-occurrence of accidents, mishaps and near misses (Hollnagel, 2014, p. 23). Although it is rather difficult to study a non-event, Hollnagel proposed giving more attention to why and how things go right (Hollnagel, 2014). In accordance with this notion, the concept of safety is not to avoid or prevent that something goes wrong, but 'to ensure that everything – or as much as possible- goes right' (Hollnagel, 2014, p. 23). This includes a focus on everyday activities, not just accidents and mishaps, as safety is understood as the ability to succeed under expected and unexpected conditions alike. Newer perspectives are increasingly involving social, cultural and technological factors in a dynamic interaction leading up to unwanted events (Antonsen, 2009; Antonsen et al., 2008; Bjerkan, 2010; Fernández-Muñiz, Montes-Peón & Vásquez-Ordás, 2007). These factors include work pace, high work demands, working environment and management practices (Bjerkan, 2010).

2.2.2 Safety Management System

Organisations operating in high risk industries must have an official policy on how to manage safety and risk related concerns. Hence, it is important to have a closer look at what safety management and Safety Management Systems actually mean. One of the most cited definitions of safety management is Kirwan's notion that it relates to the actual practices, roles and functions associated with remaining safe (Kirwan, 1998). A newer, though similar definition is that safety management are 'the policies, strategies, procedures and activities implemented or followed by the management of an organization that concerns safety of their employees' (Vinodkumar & Bhasi, 2011, p. 2083). A Safety Management System is a formalised way of dealing with these practices, roles, policies and procedures, as a 'formal arrangement, through the provision of policies, resources and processes, to ensure the safety of its work activity' (El Koursi, Mitra & Bearfield, 2007, p. 4), or, more generally, as 'a manifestation of the organization's safety culture' (Fernández-Muñiz et al., 2007, p. 53).

The purpose of a Safety Management System is to avoid incidents that may harm the environment or the company's economy, to keep the workers safe, to help the organisation meet the regulatory requirements, to accumulate and distribute knowledge and good practices, and to help the organisation as a whole to learn from experience (Antonsen et al., 2008; Bottani, Monica, & Vignali, 2009; Chen & Chen, 2012; El Koursi et al., 2007; Hale, Heming, Catfhey, & Kirwan, 1997; Norheim & Fjellheim, 2006; Santos-Reyes & Beard, 2009; Vinodkumar & Bashi, 2011). Safety Management Systems are socio-technical systems that contain all governing documentation, and can be particularly helpful for a geographically dispersed organisation in order to make sure all necessary governing documentation is available to all staff members. It is usually regarded as a sub-system of the total organisational management and as an integrated mechanism of the organisation (Dekker, 2003; Vinodkumar & Bhasi, 2011). These systems are often given different names in the industry and in the safety literature, like knowledge system, safety systems or information systems (Wold & Laumann, 2015b). Safety Management System will be the preferred term in this dissertation.

2.2.3 Governing documentation: Rules and procedures

A Safety Management System is a systemisation of the rules and procedures in an organisation, often referred to as the governing documentation. Governing documentation are formalised descriptions of how different work should be performed: work procedures, checklists, task list, instruction manuals, forms to be completed etc. (Bellamy et al., 2010; Dahl, 2013). Procedures are often seen to represent good praxis or the best thought-out way to perform a task and are used to control operator activity in a certain task to ensure goal accomplishment (Dekker, 2003; Dien, 1998; Lind, 1979). The control aspect of procedures often means to protect from human error, which again means that procedures can become rather restrictive (Dekker, 2003; Reiman, 2011). A different perspective is to see procedures not as control mechanisms but as resources to facilitate the operator in situational decision making. Procedures can probably never anticipate every single variation that might occur, so the operator should use them as resources to help structure activities while

evaluating when the procedures should be adapted to local and situational circumstances (Dekker, 2003; Schuman, 1987). These two perspectives might seem contradictory, but they can also be seen as supplementary to each other. How flexible or detailed or restrictive a procedure should be, depends on the nature of the task and the risk aspect, and is an important question for an organisation to analyse thoroughly.

2.2.4 Knowledge

Safety Management Systems and governing documentation constitutes an attempt to formalise knowledge in a manner that allows the knowledge to be distributed to and understood by a large number of people with different experience and working context. It is therefore useful to take into consideration exactly what knowledge is. The traditional scientific position has been a focus on universal knowledge, but at the same time there is an equally strong position claiming that universal knowledge is not possible, because knowledge is always context dependent (Sohlberg & Sohlberg, 2009). In the literature concerning safety in HROs there is a mix of trying to find universal knowledge that applies to all organisations of a certain kind, but at the same time taking into account the contextual factors in every organisation. A common distinction in the organisational literature is between data, knowledge and information. Data is seen as raw numbers and facts, information is processed data and knowledge is authenticated information (Alavi & Leidner, 2001). So, information is converted to knowledge in the mind of individuals. This knowledge can then be presented in the form of text, graphics or other symbolic forms, and become information again, for other individuals to take in and convert into knowledge (Alavi & Leidner, 2001). This implies that if a group of individuals should reach the same understanding of a piece of data or information, they must share a certain knowledge base. The social and organisational context of knowledge is thus emphasised, so there are three kinds of knowledge in an organisation: cultural knowledge, explicit knowledge and tacit knowledge (Alavi & Leidner, 2001; Choo, 2001). Explicit knowledge refers for instance to the governing documentation and the organisation's defined goals, while cultural knowledge refers to knowledge that is unwritten, but

still shared by all or most members of a given culture or an organisation. Tacit knowledge refers to unwritten knowledge that is shared only by certain members of a culture, in the same way that not everyone shares the same frames of references. In an organisation this can mean that a certain group of employees have their own set of tacit knowledge that the other members of the organisation are unaware about. Explicit and cultural knowledge are of lesser importance for the research questions in this dissertation, but tacit knowledge is of particular interest, as Safety Management Systems and procedures represent an attempt to avoid tacit knowledge, or to capture the tacit knowledge in an organisation and turn it into something visible and explicit that can be shared by everyone in the organisation.

2.2.5 Tacit knowledge

Performance criteria in actual work are often implicit, and can be difficult to make explicit (Rasmussen, 1997). Tacit knowledge can be seen as personal knowledge learned through extended periods of experience where the individual develops a feel for and a capacity to make intuitive judgements about the successful execution of the activity (Choo, 2001). Many professions demand a certain experience in order to get the job done right with regards to the local and situational context. In a large organisation it is almost inevitable that individuals develop different kinds of tacit knowledge, depending on their different tasks and accumulated experience (Almklov, Rosness, & Størkersen, 2014; Sohlberg, 2009). This includes the experience of adapting the procedures to local circumstances, which can over time develop into a feeling of 'the way we do things around here'. Such a development is usually not wanted, as it makes it difficult to account for how work is done and to transfer knowledge. On the other hand, if the organisation manages to account for this tacit knowledge and bring it forward to other workers who lack the same experience, it can strengthen the organisation's performance significantly (Haavik, 2010). A Safety Management System constitutes such an attempt to systematise the tacit knowledge that lies within the organisation and turn it into explicit and shared knowledge. One should be aware that in the process of generalising and standardising knowledge, one runs the risk of displacing or marginalizing local or system specific knowledge

(Almklov et al., 2014). Standardised and generalised theoretical knowledge is best combined with the experience people gain when working in a specific context. The organisational culture can be analysed as part of this context.

2.2.6 Organisational culture

Knowledge and work performance exist within a context. The general context here is the industrial organisation. The organisation exists within a larger societal context, and can also be divided into several sub-contexts. There have been several more or less successful attempts to unite the different sub-contexts into one unifying organisational culture. In this respect it is worthwhile to take a closer look at the concept of culture. Culture has been given various definitions over the years. Cultures have been characterised in terms of shared institutions, value systems, beliefs, world view, and as ways of talking about things (Shore, 1998). The definitions usually include elements of shared understandings, value systems, beliefs, world view, material artefacts and ways of talking about things (Antonsen, 2009; Guldenmund, 2007; Shore, 1998). Historical definitions of culture often place emphasis on handed-down traditions, but it might as well be shared understandings that are not necessarily handed down from generation to generation, but invented on the spot, described by Becker as a collective programming of the mind (Becker, 1998). Culture is distinguished from human nature (traits that are shared by all humans) and personality (individual traits). Culture is then the collective memory of a group intertwined with the history of that group (Guldenmund, 2007).

An organisation is simply put a group of people who do something together on a regular basis to accomplish an overall goal (Bjerkan, 2010). It is a formal unit of positions with explicit tasks, objectives, processes and assets (Bouwman et al., 2005). In most professional organisations authority and responsibility are arranged hierarchically with a bureaucratic design, including sub-units where people who perform similar tasks are gathered in clusters (Bjerkan, 2010). The culture inherent in the organisation is part of the context for any organisational study. The most common definitions of organisational culture include shared behaviours, norms and values regarding the organisation's overall goals, functions and procedure,

sometimes described as the invisible part of an organisation, meaning the normative beliefs and values that are taken for granted by the members of the organisation (Bjerkan, 2010). This is also a matter of knowing where the line must be drawn between acceptable and unacceptable behaviour (Cox, Jones, & Collinson, 2006).

The notion of culture as something shared within a group, for instance norms and values, is quite common, though one should be cautious to assume that there is one uniform culture. If one analyses organisational culture as one culture, one might overlook that there are different groups of people that might constitute different sub-groups or even subcultures within the organisation (Antonsen, 2009; Guldenmund, 2007; Rasmussen & Lundell, 2012). One cannot automatically assume that organisations are fundamentally harmonious and that all members of the organisation share a common belief that there is one objective and proper approach to reach the organisation's goals (Rasmussen & Lundell, 2012).

Within the safety literature there is a debate about whether culture should be understood as something an organisation is or as something an organisation has (Guldenmund, 2007; Sutcliffe, 2011). Both 'culture' and 'tradition' are words that organisations often use to honour themselves, related to popular associations with culture, such as deep, stable and trait (Bjerkan, 2010). Such honour words are often included in an organisation's formal goals, structure and tasks, but the more informal set of values and forms of expression shared by the members of an organisation are just as important for their actual behaviour (Bouwman et al., 2005). This relationship between formal and informal aspects of work and organising is the key to the study of organisational culture (Antonsen, 2009).

2.2.7 Safety culture

Safety culture can be considered as an integrated part of the organisational culture, rather than as something separate or in addition to the overall organisational culture (Bjerkan, 2010). Safety culture has been given various definitions over the years, but they all concern norms, values and beliefs specially related to safety (Bjerkan, 2010; Mearns, Whitaker, & Flin, 2003). IAEA defines safety culture as an assembly of characteristics and attitudes in organizations and individuals, which establishes that, as an overriding priority, plant safety issues receive the attention warranted by their significance (IAEA, 1986). A similar definition is that safety culture is 'the set of beliefs, norms, attitudes, roles and social and technical practices within an organization which are concerned with minimizing the exposure of individuals both within and outside an organization to conditions which are considered to be dangerous' (Pidgeon & O'Leary, 1994, p. 32). A more social psychological definition of safety culture is that it is 'the product of individual and group values, attitudes, perceptions, competencies, and the patterns of behaviours that determine the commitments to and the style and proficiency of, an organization's health and safety management' (Health and Safety Executive, 1993, p. 23). Safety climate is a related concept, and can be regarded as a manifestation of safety culture in the behaviour and expressed attitude of employees (Mearns et al., 2003), or an organisation's state of safety (Vinodkumar & Bhasi, 2010). It is becoming accepted that a good safety climate is important for safe conduct, though it is less clear exactly which factors promote a good safety climate (Bjerkan, 2010; Guldenmund, 2007; Mearns et al., 2003). Safety culture applies to all levels of the organisation, but is too often regarded as a shop floor problem, where managers complain about workers not doing what they are told do to (Heimplaetzer & Busch, 2007). Most companies in hazardous industries today have programmes devoted to improvement of the company's safety culture, although the assumption that there is a relationship between culture and safety has not been subject to thorough empirical investigations and discussions (Antonsen, 2009).

2.2.8 Human factors

The focus on Safety Management Systems, knowledge and organisational culture implies a holistic approach to safety in which perspectives from human factors can be useful. Human factors initially focused narrowly on human interactions with physical devices, but the scope has broadened to include team working and aspects of work and organisational design (Andersen, 2013; Stanton, Salmon, Walker, Baber, & Jenkins, 2005). Human factors relates to ergonomics, engineering psychology, and cognitive engineering, though without any tightly defined boundaries (Wickens et al., 2004). The scope includes physical aspects of work as well as cognition and mental interactions, and information presentation, workplace design and social and economic impacts (Andersen, 2013; Salvendy, 2006; Stanton et al., 2005; Wickens et al., 2004). Production and maintenance processes, including operator support such as procedures and training, relate to the physical and cognitive interaction between human and the system. The European Committee for Standardization has stated that humans should be considered as the main factor and an integral part of the system when work systems are being designed (EN ISO 6385, 2004). The work environment, including operator support such as procedures and training, must be designed to assist the human operators to undertake their tasks and safely effectively.

3 Research design and method

The methodological choices in a research project should be made on the basis of what the goal of the research project is and what application the collected data is supposed to have (Corbin & Strauss, 2008; Kvale, 1996), as portrayed in the way Kvale referred to the original Greek definition of the word method: 'a route that leads to the goal' (Kvale, 1996, p. 4). Hammersley and Atkinson pointed out that the research questions often need to be developed or even changed during the collection and analysis of data. One might come a long way in the research process before one discovers the essence of the research project, and this might be something quite different than what one initially had in mind (Hammersley & Atkinson, 1996). One must always be open to the possibility that the research problem or other aspect of the project must be adjusted or further developed during the course of the work, but flexibility in scientific research has never meant that it should be without a set direction. According to Morley, all questions of methodology are ultimately pragmatic ones, determined by available resources and the particular type of data needed to answer specific questions (Morley, 1992). For instance, there is always economy involved, setting limits including how many informants one can have, how long one can observe in the field and how much data one can process.

Qualitative interview was chosen to obtain a deeper understanding of how the executives and operators understood the Safety Management System and the procedures. Some research topics are best served with qualitative methods, for instance when trying to examine the individual's experience of a phenomenon. Qualitative methods can here yield more intricate details that are difficult to obtain by using quantitative methods (Charmaz, 2001; Corbin & Strauss, 2008; Cresswell & Miller, 2000). The purpose was to gain an understanding of the informants' knowledge, attitude and experience concerning the use of the Safety Management System and the procedures. Open ended questions allowed them to elaborate in their own words what they saw as the main challenges, problems and advantages with the

management system. This gives a more fruitful account for what is going on than would be obtained by using questionnaires.

3.1 Subject of study

The empirical data was collected by conducting qualitative in-depth interviews with 27 staff members from two different companies in the Norwegian gas and petroleum producing sector, hereby named Company A and Company B.

3.1.1 *The two companies*

Company A operates a gas and petroleum installation on the Norwegian shelf. They have developed their own Safety Management System. Three informants were onshore executives from Company A who have had an active role in the development of the company's Safety Management System. These three informants were interviewed in a preparatory study to gain insight into what their priorities were when developing the Safety Management System, and how they thought it should be put to use on the offshore facility. The second interview round was with five offshore executives and 10 offshore workers in Company A, all on the same installation, representing different disciplines: mechanics, electricians, logistics and automation. These informants were interviewed on board the offshore installation during their normal working hours in a separate room.

Company B hires out workers to companies in the offshore gas and petroleum production (not Company A), and also engineering work onshore. As a consequence, the informants from Company B alternate between working onshore and offshore, and for different companies. Company B has developed their own Safety Management System, but when their workers are on the installation of another company, the management system of the hiring company takes precedence. The third interview round was with nine foremen and installation leaders from Company B. The interviews were conducted onshore during their normal working hours, in a separate room.

3.1.2 The Safety Management System

The Safety Management Systems used by the two companies in this study are similar to each other, and are set up as intranets. Every employee has their own personal user account which they can use to log on to the intranet from their own computer. In addition, there are computers in the lounge area where the workers can access a smaller version of the management system without logging in. The management systems are organised in a hierarchic folder system. The employees start by clicking on one of the main folders, for instance 'Administration' or 'Operation and maintenance'. Every folder contains clickable icons denoting various areas of work, for instance 'Hot Work Class B'. Every click on an icon navigates the workers further down the hierarchy until they reach the exact work procedure or checklist that they need for the planned task.

The Safety Management Systems in both companies contain procedures for all tasks at all levels in the companies. They contain procedures and checklists for tasks at the sharp end, for ordering new equipment, for administrative tasks, for reporting overtime etc. Operators and executives are expected to use the Safety Management System routinely to make sure they perform their given tasks according to official guidelines and company values. The analysis in this study focuses on the operators' use of the Safety Management System and their understanding of it.

3.1.3 Descriptions of informants

The selection of informants was done strategically to get units rich on information, according to the logic of purposeful sample (Morrow, 2005; Patton, 2002). The informants in this project were not chosen randomly, but from predefined criteria that fit the object of the study. The informants had to be from companies involved in a high risk industry, more precisely oil and petroleum production, and who were using or at least were supposed to use the Safety Management System on a regular basis. Another criterion was to get a mix of onshore executives, offshore executives like installation managers and foremen, and offshore workers at the sharp end: automation, electricians, mechanics and process workers. The informants were picked in collaboration with the management in the companies, and they were either

permanent employees or long term contractors. A complete overview of the informants is included in the appendix. A summary will be given here.

Table 1

Informants by position in company

	Company A	Company B
Onshore	3	1
Offshore	5	7
Field operators	10	1
Total	18	9

Offshore executives include offshore installation managers, operations support leaders, HMS team leaders, operations and maintenance manager, operations support managers and foremen. Field operators include electricians, mechanics, automation, crane operators, laboratory technicians and logistics.

In company A all the offshore executives and the field operators were working on the same offshore installation. The informants in Company B were on different installations as contract workers, and also alternated with working on land. The offshore executives in Company B were all leaders for the contract workers from their company when they were hired out for a customer. At the offshore installation, they served as the link between the company in charge of the installation and the team of contractors from Company B. They all alternated between working onshore and offshore, and were interviewed while working onshore.

Gender was not a selection criterion in this project. Almost all of the offshore executive and field operators in both companies were men, so it made no sense to try and get an even distribution of men and women. Three informants from Company A were women: one onshore executive, one offshore executive, and one field worker. They were chosen because of their professional position, not gender.

Table 2*Informants by age*

Age	Company A	Company B	Total
25-29	1	1	2
30-34	0	1	2
35-39	1	1	2
40-44	4	1	5
45-49	7	2	9
50-54	3	1	4
55-59	0	2	2
60-64	2	0	2
Total	18	9	27

Age was not a selection criterion, but it was desirable to get some variation in how experienced they were. A few young informants were in their early years as offshore workers. The majority of the informants were in the age group 40-54, but their offshore experience varied a lot. Several of them had done various jobs on land before switching to offshore, and some of them alternated between working onshore and offshore. This was particularly the case with the informants from Company B.

Table 3*Informants by offshore experience*

Years offshore	Company A	Company B	Total
0	2	1	3
1-9	7	6	13
10-19	6	2	8
20-29	2	0	2
30-39	1	0	1
Total	18	9	27

3.2 The data collection process

The interviews followed a semi-structured interview guide¹. The semi-structured interview is 'an interview whose purpose is to obtain descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomena' (Kvale, 1996, p. 5-6). The first minutes of an interview can be particularly important to set the tone and to create a good atmosphere for the rest of the interview where the informant feels he or she can talk unrestrained (Hammersley & Atkinson, 1996; Kvale, 1996). In this phase the interviewer should also inform about the purpose of the interview, how the data will be used, assurance about anonymity and the opportunity to back out from the interview at any point (Hammersley & Atkinson, 1996; Kvale, 1996). For many people it is more comfortable to be interviewed on their own turf, where they can organise the context as they like, while sometimes it will be necessary to create a situation apart from the daily context (Kvale, 1996). One should also consider how the interview will fit into the informant's ordinary day. If it becomes too inconvenient for them many informants are likely to reject the inquiry (Hammersley & Atkinson, 1996). For the quality of the sound recording and for the flow of the interview, it is best to find an undisturbed place without too much background noise and without the danger of being interrupted by colleagues or others (Hammersley & Atkinson, 1996; Kvale, 1996).

The purpose of the interviews was to gain an understanding of the informants' knowledge, attitude and experience concerning the use of the Safety Management System and the procedures. Certain topics were planned in advance, but questions were open ended, allowing the informants to bring new topics to the table, and also allowing for the structure of each interview to be different according to how the informant understood the various topics. The first questions dealt with personal background: age, gender, education and work experience, then the informants told about their daily job routines and tasks. They were then asked to describe the Safety

¹ See appendix for interview guide in Norwegian and English.

Management System and the purpose of it, before the questions became more detailed: which procedures they used and in which situations, how they learned about the Safety Management System, about the user friendliness of the system, shortcomings and advantages. The duration of the interviews was 30-45 minutes, with a few exceptions. The interviews with the executives generally lasted longer than the interviews with the operators.

The interviews were conducted and transcribed by the author of this dissertation. Transcription was done word by word, as thematic analysis does not require the same level of detail in the transcript as conversation, discourse or narrative analysis (Braun & Clarke, 2006). Stops and laughter were indicated, and the transcription was written in normal written language, not dialect. The transcription process also functioned as a step in becoming familiar with the material as a first step in the analytical process (Braun & Clarke, 2006; Howitt, 2010; Kvale & Brinkmann, 2009).

3.3 Thematic analysis

Thematic analysis is a theory-flexible approach for identifying, analysing and reporting patterns in qualitative material (Attride-Sterling, 2001; Aronson, 1994; Braun & Clarke, 2006; Howitt, 2010). It resembles inductive content analysis with open coding in the way the categories emerge out of the data and not from an existing theoretical framework (Corbin & Strauss, 2008; Dahl, 2013; Patton, 2002). In thematic analysis data are examined in order to identify relatively broad themes, and thematic networks are developed to help the structuring and depiction of these themes (Attride-Sterling, 2001; Howitt, 2010; Tuckett, 2005). Each interview segment is coded in as many themes as relevant, and then the segments within each theme are compared (Tuckett, 2005). Based on the researcher's judgement some themes will be developed further, some will be broken up in several sub-themes, while other themes do not have enough data to qualify as themes (Attride-Sterling, 2001; Braun & Clarke, 2006; Howitt, 2010).

The first step in the analytical process was to become familiar with the data material, which was done by transcribing the interviews and reading through the transcripts. The second step was to generate initial codes. To do this, the transcribed material was fed into the software programme NVIVO 10 and ordered into rather broad categories, mainly based on the questions in the interview guide². Each segment was coded in several categories, with surrounding data intact to keep track of the context. Some topics had a starting point in the pre-planned questions in the interview guide, but new topics emerged during the interview process, and some topics emerged when looking at certain keywords mentioned by some of the informants, and by looking at the context in which they mentioned these words.

Table 4 - Excerpts³
Coding table from step 2

Topic	Sources	References
Describe the management system	25	34
Describe a specific procedure	18	21
Do you use many procedures	2	2
User friendliness	17	21
Optimism	12	23
Do you talk about the management system with your colleagues	19	26
Discussions about the management system	6	7
Detailed procedures	5	8
Own solutions	5	10

Table note: Sources refer to how many informants said something about this topic. References refer to how many codings were done for this topic. The full table is included in the appendix

This is a preliminary coding that does not really say much, only how many informants said something about a given topic, and how many times we touched on a topic. It gives no information on how much or what the informants said about each topic, but it gives some indication about what topics were mentioned most often and might be relevant for further development into themes. ‘Descriptions of the management system’ is not useful as a theme in itself. One must look at how the

² The interview guide is included in the appendix.

³ The full table is included in the appendix.

informants describe the management system, and in this context it is also relevant to look at how they describe the procedures, what they see as advantages and disadvantages.

The third step was a new reading of the coded material for each topic, with more focus on developing themes and sub-themes under each topic, and how the themes under one topic might be related to themes under a different topic. This step gave a better overview of the main topics of the material. After this round of coding it became clear which topics could be developed into themes and which topics did not hold enough material to qualify as themes. For instance, communication was one of the initial topics, with face-to-face communication and mediated communication emerging as sub-themes.

Table 5 - Excerpts⁴

Coding table from step 3

Vague descriptions of the management system
- What they think the system is
- What is the purpose of the system
- When do they use it
- A tool
User friendliness
Informal procedures
-Their own solutions:
- Print outs
- Unofficial web page
Purpose
- Self interest
- Safety: vague
Main function
- Safety: vague
- For managers to cover their back
- To comply with official regulations

⁴ The complete table is included in the appendix

The fourth step was a review of the themes from this table. It was evident here that some of the themes did not hold enough material to qualify as a theme, and were dropped from further analysis. Other themes were developed further, and had cross-overs with other themes. The theme 'user friendliness' for instance had cross-overs with navigation, information overload, language, access to procedures, informal procedures and finding work permits. A variety of categories were related to the Safety Management System: reasons for not using it, user-friendliness, navigation, language and information overload. Other themes to emerge were routine tasks, professionalism and safety development. The fifth step in the process was to review the themes for further evaluation. In this step, the main themes were developed.

Table 6
Main themes

Vague descriptions of the management system
Communication
User friendliness
Dislike computers
Training
Organisational context
Information overload
Language
Informal procedures
Ideals of professionalism

The sixth step was another reading of each theme to further define the themes and sub-themes, which are shown in Table 7. The writing process involved a last step of analysis with presentation of material in mind. Several of the main themes had overlapping sub-themes. For instance 'dislike computers' was relevant both under communication and user-friendliness, and also qualified as a main theme. For sub-themes that were shared by several themes, or were overlapping, a last evaluation was made to decide where it fit best to present it. During the entire analytical process I went back and forth between the different steps.

Table 7

Main themes and sub-themes

Main themes	Sub-themes
Vague descriptions of the management system	What they think the system is
	When do they use it
	What is the purpose of the system
	Safety
Communication	Two way communication
	Feedback
	Use of computers
	Interpretation of information
	Language
	Information overload
	Experience
Management system as a tool	
User friendliness	Difficult to navigate
	Information overload
	Language
	Dislike computers
	Creating their own solutions
	Finding work permits
Access to procedures	
Dislike computers	Adds to the work load
	Not seen as real work
	Prefer to just go out and do the job
	Executives expect the workers to be familiar with computers
Training	Web course
	No repetition
	Learning by doing
	Buddy system
	Wants practical exercises
Skill decay	
Organizational context	Use of technology/computers
	Language differences
	Interpretation of information
	Different experience
	Different work environment
Collaborative community	
Information overload	Many procedures
	A jungle of procedures
	Difficult to navigate
Language	Difficult words
	English
	Academic English
	A way for the management to show off
Informal procedures	More practical to use
	Print out a pile of checklists
	Create their own web page
Ideals of professionalism	Using their own judgement instead of procedures
	Do not need the management system if you know how to do your job
	Management system as paper work
	Management system as a means to keep the idiot safe

3.4 Validity

The common definition of validity in quantitative studies is whether an instrument or method actually measures what it is intended to measure or whether it gives a truthful answer (Ali & Yusof, 2011; Kuzmanic, 2009). Several researchers have argued that it is problematic to use this definition to assess validity in qualitative research (Kuzmanic, 2009; Kvale, 1996; Meyrick, 2006; Nura, 2014). However, the concepts of internal and external validity can still be useful to discuss the quality of qualitative studies, together with phenomenology and transferability.

3.4.1 Internal validity

In qualitative studies validity can be understood as how accurately the data represents the participant's understanding of the phenomenon (Ali & Yusof, 2011; Cresswell & Miller, 2000; Kvale, 1996; Kvale & Brinman, 2009; Whittmore et al., 2001). This is often referred to as internal validity (Ali & Yusof, 2011; Guba & Lincoln, 1994; Kvale, 1996). Internal validity can be accounted for through detailed explanation of the steps the researcher took from data collection to conclusion, detailed account on interview technique and also reflection on how the researcher and the participants or the situation influenced this process. Collection of data is an important aspect for judging validity, as well as data presentation and interpretation (Ali & Yusof, 2011; Flick, 2002; 2007; Kuzmanic, 2009; Meyrick, 2006). This validation should be a part of every step in the research process, including the theoretical background for the research project (Ali & Yusof, 2011; Kuzmanic, 2009; Kvale, 1996; Kvale & Brinkmann, 2009). This involves a continuous self-evaluation during the research process, a challenging exercise (Corbin & Strauss, 2008). Such an evaluation should make clear if one has mapped the comprehensiveness of the research field, if the presentation of the data material is adequate, if there is an unambiguous and logical coherence between the categories, and if the findings are useful (Charmaz, 2006; Corbin & Strauss, 2008; Flick, 2007).

3.4.2 External validity

External validity refers to the generalizability of the results. Generalizability of research findings is commonly defined as the degree to which the findings from a study sample can be generalized to the entire population (Ali & Yusuf, 2011; Guba & Lincoln, 1994). A common objection to qualitative research projects is that the sample is too small and unrepresentative, and that because of this the results do not permit confident generalization from the sample to a population (Hammersley & Atkinson, 1996; Kvale, 1996; Yardley, 2000).

The distinction between quantitative and qualitative research methods is perhaps best captured in the different strategies, logic and purposes that distinguish statistical probability sampling from qualitative purposeful sampling (Patton, 2002, p. 46). While quantitative methods depend on large randomly selected samples in order to generalise from the sample to the population it represents, the strategy of purposeful sample is to perform in-depth studies of a phenomenon. The concept of sampling from a population of sites in order to generalize to a larger population will only work in very rare instances in qualitative research. In contrast to the large samples in quantitative studies, qualitative research deals with a limited sample, sometimes single cases, to allow for a deeper exploration (Kvale, 1996; Patton, 2002; Yardley, 2000). Informants are chosen for their special attributes, for example because they are extreme or typical exemplars of the phenomenon of interest (Nura, 2014; Yardley, 2000). The selection of study objects, or informants, is done strategically to get units rich on information about certain themes of great importance for the purpose of the project, hence the term purposeful sample (Morrow, 2005; Patton, 2002). Patton warned about using convenience sampling, which is never purposeful, although economy and time limits are real factors in any research project (Patton, 2002).

Using a thick description of the phenomenon and the context, one may argue for an analytical generalization (Patton, 2002; Schofield, 1990). The logic of qualitative reasoning is that a single case is sufficient in order to claim that this is the real case, providing us with an empirical basis to describe something more generally according to the notion of analytical generalization (Ali & Yusuf, 2011; Kvale, 1996; Patton,

2002). The researcher cannot automatically claim that there are more cases like this, but that there is at least one. Schofield argued that 'the classical view of external validity is of little help to qualitative researchers interested in finding ways of enhancing the likelihood that their work will speak to situations beyond the one immediately studied' (Schofield, 1990, p. 205). This concept of validity refers not to the data but to the conclusions drawn from them (Ali & Yusof, 2011; Cresswell & Miller, 2000; Hammersley & Atkinson, 1983).

3.4.3 Phenomenology and transferability

The qualitative research interview is connected to an interpretative paradigm. Kvale (1983; 1996) anchored qualitative methods to hermeneutics, where focus is on the meaning and interpretation of texts, and phenomenology, where focus is on describing people's life world, their thoughts and experiences. In the qualitative research interview the researcher tries to understand a phenomenon from the interviewee's point of view, and to put this into a larger meaning perspective (Elliott, Fischer, & Rennie, 1999; Kvale, 1983; 1996; Patton, 2002). Phenomenology is an important tradition in social sciences, and deals with how our consciousness transforms our sense perceptions into recognisable objects. This deals not only with what we can see and measure, but also with how we gain knowledge by use of imagination and language (Benton & Craib, 2001). In psychology, the purpose of a phenomenological approach is to gain insight into how the informants make sense of a given phenomenon in a given context, using qualitative methods. In the qualitative research interview the researcher tries to understand a phenomenon from the interviewee's point of view, and to put this into a larger meaning perspective (Elliott et al., 1999; Kuzmanic, 2009; Kvale, 1983; 1996; Patton, 2002). The semi-structured interview is 'an interview whose purpose is to obtain descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomena' (Kvale, 1996, p. 5-6). It is the particular situations and experiences of the individuals participating in the study that are of explicit concern in many qualitative studies, and how they construct and negotiate meaning (Elliott et al., 1999; Yardley, 2000). The qualitative interview also builds on constructionism, where social life is

seen as built in action, and hence it is only the participants that can define what is going on in their own place and time (Abbott, 2004). Of course one should not trust blindly what the participants say about their own world, or, as Becker said, 'treat 'people`s knowledge as better or more valid than ours' (Becker, 1998, p. 98), but their account of what is going on can be fruitful for an analysis of an organisation`s tacit and explicit knowledge. This is by some researcher referred to as transferability, defined as the degree to which the results of qualitative research can be transferred to other contexts or settings (Nura, 2014; Rolfe, 2006).

3.4.4 Validity of this study

The aim of this project is not to generate quantifiable results. The aim is rather to produce a coherent and explanatory presentation of an issue based on a detailed description of a given case, which can form a foundation for a comparison with similar cases. A particular problem related to communication discovered at an offshore installation in this study cannot automatically be said to apply to all offshore installations, but it forms an empirical foundation to describe the problem. This is an inductive approach leading to findings about offshore installation workers and their understanding of Safety Management Systems, suggesting that the findings can be relevant for similar situations, but not necessarily to all offshore installations. These findings cannot be generalized in a positivist traditional way.

In this process, it is important that research provides enough detail about the group studied and the context in which they were studied, allowing the reader to make a judgement about how far they wish to extrapolate or transfer these findings to other groups (Meyrick, 2006). Even with a small sample as in a qualitative study, it is preferable to have a theoretically selected group of informants chosen for their attributes (Yardley, 2000). This has been done in this study by selecting informants from different parts of the organisations: onshore executives, offshore executives, group leaders, foremen, mechanics, electricians, permanent employees and contractors.

The findings and analysis from this study might be relevant for other similar situations. For instance, the analysis of the platform workers and their understanding of the management system might be relevant for other contexts, not necessarily to all gas and petroleum producing installations, although direct comparisons to other industries operating in an hazardous environment cannot be made here, but must be made based on thorough knowledge about each particular place of work.

3.5 Reliability

Reliability is also often defined as the extent to which the results can be replicated, or the reassurance that another researcher investigating the same issue or working with the same data set would derive the same findings. But there are conflicting views as to how reliability is relevant in qualitative research (Ali & Yusof, 2011; Flick, 2007; Guba & Lincoln, 1994). Reproducibility is by many considered irrelevant because in qualitative research, the researcher is commonly interested in practices that are strongly tied to a specific context (including time and place) (Ali & Yusof, 2011; Flick, 2007; Guba & Lincoln, 1994; Merrick, 1999; Nura, 2014). Others also argue that you cannot doubt the truth in the informant's statements as long as you are asking for their own experiences (Fog, 1995; Smith, 1998; 2005). Rather, reliability in qualitative research is about methodological coherence: to ensure congruence between the research question and the components of the method (Nura, 2014). Reliability can thus be reformulated in a more procedural conception (Flick, 2007). The aim for the researcher is then to make the production of data transparent and to explain the methodological framework that has been used in the study, how the participants were selected and explaining the researcher's role (Ali & Yusof, 2011; Flick, 2007).

3.5.1 Reliability of this study

I have conducted the interviews and transcribed them myself. The transcribed text in itself has thus not caused any misunderstandings, since I know the context of the interviews. That I have done all the steps in the process by myself is though not a guarantee for reliability. At worst, this can obscure misunderstandings and misinterpretations. In order to avoid this I have had open dialogue and discussions throughout the process with my supervisor and my colleagues at the Centre for

Safety and Human Factors about the questions I have asked the informants, how they answered and how the material can be interpreted and analysed.

3.6 Transparency and reflexivity in qualitative research

Several researchers have argued that reliability and replicability can be inadequate criteria to evaluate a qualitative study, as the purpose of the research sometimes is to offer just one of many possible interpretations of a phenomenon, and because it is impossible to exclude subjectivity in the interpretation of the data. Many approaches to quality in qualitative research have been suggested and debated without reaching a unanimous conclusion. However, there seems to be agreement on the importance of transparency or disclosure of all relevant research processes (Flick, 2007; Kuzmanic, 2009; Meyrick, 2006; Yardley, 2000). Sensitivity to context, commitment and rigour, transparency and coherence are also often suggested as important principles for a qualitative study to have any impact and importance in a wider perspective (Meyrick, 2006; Morrow, 2005; Nura, 2014; Yardley, 2000). This is similar to the concept of trustworthiness of observations and data as a standard for good practice (Elliott et al., 1999).

There are several steps that can be taken to ensure rigour, transparency and coherence in a qualitative research project. The researcher must include sufficient detail about how the data were collected, such as a description of the context and how and why there were changes in techniques or focus (Meyrick, 2006). This includes disclosure of the researcher's orientation and preconceptions, explications of the social and cultural context of the research, description of the internal process, repeated cycling between interpretation and data and relating findings to existing knowledge. One should also give evidence of the usefulness of the interpretation for fostering change both within the research area and with how the researcher thinks about the phenomenon (Elliott et al., 1999; Morrow, 2005; Yardley, 2000). The purpose is not to falsify or strengthen predefined hypothesis, but rather to build categories from the collected information, and in continuation of this, create new hypotheses or theories. The researcher needs to be reflexive and disclose what they

bring to a narrative (Cresswell & Miller, 2000; Darawsheh 2014; Flick, 2007; Kuzmanic, 2009; Yardley, 2000). Reflexivity is the continuous process of self-reflection that researchers engage in to generate awareness about their actions and perceptions in the research process (Darawsheh, 2014; Nura, 2014). This should be a part of every step in the research process, including the theoretical background for the interviews (Ali & Yusof, 2011; Kuzmanic, 2009; Kvale, 1996; Kvale & Brinkmann, 2009). This involves continuous self-evaluation during the research process, a challenging exercise (Corbin & Strauss, 2008).

3.7 Summary of the methods used in this study

In this chapter I have described what I have done to address the research problems, and the methodological choices I have made, in order to strengthen the validity of the research (Yardley, 2000). Qualitative interview was chosen to obtain a deeper understanding of how the executives and operators understood the Safety Management System and the procedures. The interviews were conducted and transcribed by the author of this dissertation. Transcription was done word by word. The informants have been chosen according to the logic of purposeful selection. They were chosen because they are assumed to have broader relevance to a subject of concern to other sites than the ones in the sample. I have presented relevant information about the informants while keeping their status as anonymous.

I have tried to increase the transparency of this study by providing information about every step of the data collection process and the steps in the analysis. The interview guide is included in the appendix, although during some interviews there emerged questions that were not pre-planned. This was due to information that the informants gave, and I evaluated the need for extra questions about that information. This is a natural part of semi-structured qualitative interviews. During the interviews I asked elaborative questions and control question to make sure I had understood what the informant meant to say. I also tried to avoid bringing analytical concepts or evaluations into the interview situation (Kvale, 1996). The interviews were conducted at the informants' place of work during their normal working hours in a separate

room with no interruptions. I have presented how the transcription was done, and given details and examples about the steps in the coding process.

The analysis was inductive, where data were coded without having to fit in any given frame. As Braun and Clarke (2006) recommended, the interviews were interpreted in a literal sense, without searching for latent or hidden messages in the interviews. I have tried to interpret the data as objectively as possible with a systematic reflexivity throughout the entire process. I also followed the recommendation to read the interview material several times to see if the categories and interpretations made sense (Cresswell & Miller, 2000; Kvale, 1996). I have also had peer debriefing in the form of discussions with research colleagues and my supervisor, and we have reviewed the findings in meetings.

I have presented the material as completely as possible, with interview guides and appendixes showing the process of developing themes. In chapter 5, quotes from the interviews will also be used to show the basis for the interpretation that the researcher has done. The decisions about what parts of the material were most important are still based on my own judgement, supplemented with discussion with colleagues. I cannot guarantee that a different researcher would have conducted the interviews in the same way and interpreted the data the same way as I have, nor can I guarantee that I have analysed any possible connection within the data material and not missed anything. A method cannot give such guarantees, which makes it even more important to be cautious when evaluating what kinds of questions the analysis can answer.

The collected data cannot be used to make general conclusions about the population of offshore workers as a whole, but it will be feasible to utilise the conclusions from the study to understand similar situations. The aim of this analysis is not to compare the Safety Management Systems to systems in other organisations or industries or to review guidelines from safety authorities. Instead, this research is a case study on the use of Safety Management Systems in two organisations with particular focus on the communicational aspects. Based on Sake's discussion of generalization from case

studies, Kvale described this as analytical generalization involving a 'reasoned judgement about the extent to which the findings from one study can be used as a guide to what might occur in another situation' (Kvale, 1996, p. 233). This kind of generalization is based on an analysis of the similarities and the differences between the two situations.

3.8 Ethics

All interviewees were informed that their answers would be treated anonymously and in strict confidence and that the recordings and transcriptions would be stored securely and deleted after use. The informants were also informed that they could withdraw from the interview at any time. The interviews were transcribed without any personally identifying elements, and the names of the companies and the installations were also anonymised. The method of collection and storing of interview data in this project has been reported to and approved by Norwegian Social Science Data Services (NSD - <http://www.nsd.uib.no/>).

4 Findings

This chapter offers a short summary of the main findings in the four research papers included in this dissertation.

4.1 Paper 1: Safety Management System: Definitions, challenges for use and recommendations for improvements. (Wold & Laumann, 2015b)

For the literature review, a variety of papers from organisational theory, safety science, IT studies and psychology were researched. The purpose of this paper was to give a review of research literature relevant to IT-based Safety Management Systems, to describe the purpose of such systems and the challenges with using them, and to come to a unifying definition. The papers used different terms, like information system, knowledge system and management system, but they all described the systems in somewhat similar terms: as IT-based superstructures, or umbrellas, containing procedures, descriptions and checklists on how different tasks should be performed, and what kind of safety standards different tasks requires. I found it best to use the term Safety Management System, and to define it as an IT-based system whose purpose is to code and share good practices, create corporate knowledge directories and to create knowledge networks for the organisation. The most common challenges with using Safety Management System addressed in the research literature were related to the workers' ideals of professionalism, procedure overload and lack of flexibility.

Several studies found that deliberate deviations from procedure often were grounded in a well-intentioned desire to get the job done effectively. This was also related to symbolic values and ideals of professionalism among the workers. Being able to outsmart hierarchical control and to compensate for higher-level deficiencies becomes a signal of competence. To counteract such a development, organisations need to establish the idea that being able to use the Safety Management System and the procedures in an effective manner is a sign of competence and professionalism.

The large amount of procedures that an organisation accumulates over time was addressed in many of the papers. A procedure overload makes it difficult for the individual to navigate the management system. One also runs the risk of creating procedures that are in contradiction with each other. A large amount of detailed procedures was also recognised as a reason for decreased flexibility in the organisation. The need for standardisation might lead to extensive rules and procedures, which in turn can lead to over-reliance where the worker either does not dare or does not know how to adapt the procedures to the immediate situation. Many organisations need to tidy up the procedures and to evaluate thoroughly what kind of new procedures they really need and how detailed they should be.

In most of the papers, Safety Management Systems were simply regarded as tools, but they should rather be regarded as communication systems. This is a perspective that has been lacking in the research literature. Several authors stressed the human component, but usually in the perspective of how to get the workers to use the technology in a better way. How people understand technology was usually not discussed, neither were the communication aspects of an IT-based Safety Management System. The social and cultural facets of knowledge management should be given more attention, not only the technical requirements. The Safety Management System is constructed at an executive level in the organisation and distributed to the lower levels. At the lower levels, it must be interpreted by the users, but there is no guarantee that it will be interpreted and understood as intended. By analysing this as a communication process one can identify the various understandings or misunderstandings that might occur. People with different roles in the organisation will have different frames of reference, and this affects how they understand the Safety Management System. It can be useful to consider how some frames of references are shared by the entire organisation, and at the same time, how each level of the organisation might have specific frames of references which are unknown at the other levels in the organisation. Different subcultures within the organisation might have different frames of references. A central topic for further research should be how the workers interpret and understand the procedures and

the Safety Management System, and how their interpretation affects how they use the Safety Management System. In-house training is essential in order to get the workers to use the Safety Management System as intended, and for the workers to see why it is important. In the same way as machines must be designed to suit the physical abilities of the expected user, also instructions and procedures must be designed to fit the cognitive, informational and emotional processes in the human being.

4.2 Paper 2: Safety Management Systems as Communication in an Oil and Gas Producing Company (Wold & Laumann, 2015a)

In this paper, empirical data from a study conducted in a gas and petroleum producing company were presented (Company A). The purpose of this paper was to investigate how an IT-based Safety Management System is being used in a given context, and to discuss the potential for improvement both in the Safety Management System itself and in the use of it, by analysing the Safety Management System not merely as a tool, but as a communication system.

18 informants were interviewed qualitatively, using a semi-structured interview guide with questions concerning the Safety Management System: how they would describe it, how often they used it and for what purposes, what they saw as main advantages and disadvantages with the management system. Three of the informants were onshore executives who were involved in the development and implementation of the Safety Management System. Five informants were offshore executives and 10 were offshore operators.

The most striking finding in this study was that executives and workers related to the management system very differently. The onshore management in the organisation expected the employees to check the procedures every time they were going to perform a task, although they acknowledged that this would be impractical and time-consuming. Onshore and offshore executives were aware that the operators do not use the Safety Management System as often as they are supposed to, but claimed that the operators still work accordingly to given procedures and safety standards.

The offshore workers knew they were supposed to use the Safety Management System on a daily basis, but most of them estimated that they used it once a week on average, sometimes less. They mostly used it for tasks that were not part of the ordinary routine or tasks that they only do a few times a year. The offshore operators said they felt no need to use the Safety Management System and that they could do their job just fine without it.

In general, the informants were a bit unclear when talking about the Safety Management System. The executives' attitude seemed a bit motivated by the acknowledgement that they must have some sort of management system. They pointed to weaknesses or imperfections in the system, but also said that there was an ongoing process of improving these weaknesses, or 'the continuous improvement phase' as some of them called it. However, they were unspecific about what they have done or should do in order to achieve this improvement.

The operators were vague when they tried to describe the purpose of the Safety Management System. They said it had something to do with safety, but most of them were not able to explain exactly how the Safety Management System would increase safety. As a consequence, they saw the system as less important, and this view negatively influenced their motivation for use. They saw their own knowledge and competence to do their job properly as more important for safety than the Safety Management System.

The few informants who used the Safety Management System more regularly said they enjoyed having all the work descriptions, checklists and legal demands gathered in one place. But they also said it was difficult to navigate in the system, and that they had to skim through a lot of material they did not need in order to find the stuff they needed. They also would prefer if it was more clearly stated which of the demands were invariable and when there was room for individual judgment. The informants thought that the procedures and checklists were good, but finding them was difficult.

The executives said that the Safety Management System was easy to use, but according to the operators, it was not, and they did not enjoy using computers. A user analysis identifying the skills and predispositions of the operators would be helpful in developing a system that better fits the users. The users must also be allowed to give feedback about their experience with the different procedures. In the current management system, there is in fact a possibility for the operator to give feedback about the procedures, but most of the operators were not aware of this

possibility. If such a possibility is enhanced, it is not certain that it will lead to a plethora of new adjustments, but it may function as a signal that the accumulated experience of the operators forms an important foundation for the development of procedures. This will be helpful in the process of giving the operators a sense of ownership regarding the procedures and the Safety Management System, and will help them to understand the purpose of it. This is important, as those informants who were able to say something about the purpose of the Safety Management System had a much better use of it than those who could not. The key to such a development lies in proper communication and training.

4.3 Paper 3: End user involvement in the development of procedures and Safety Management System? (Wold & Laumann, 2014)

End user involvement in the development of procedures demands resources, but can be beneficial. This paper focused not on the costs, but the potential benefits of end user involvement, building on data from qualitative interviews with 27 executives and operators in two different companies involved in gas and petroleum production on the Norwegian Continental Shelf.

The main finding presented in this paper was that the informants who had at least to some extent been involved in the development of the procedures, had a feeling of ownership regarding the Safety Management System, while the ones who had not been involved at all felt no ownership towards the management system, and they did not understand the purpose of it.

If operators are involved in the development and the implementation of the management system and the procedures, this will help to create a feeling of ownership towards the system and an understanding that it is rooted in the practical competence and experience of operators. End user involvement can also help to bring forward tacit knowledge in the organisation and make invisible work processes visible and transparent. This helps to avoid a culture of tacit knowledge where the ones who perform a specific task are the only ones able to account for exactly how the task should be performed. An operator will over time develop a natural feel for how the job is best done and a capacity to make intuitive judgements about when and how to adapt the procedures to the immediate situation. This knowledge can be transferred to other parts of the organisation, and brought forward to other operators and to executives who lack the same experience.

This is easier said than done, but it requires a dynamic communication between operators, management and safety experts. Procedures must be adjusted based on the views of those directly involved. Two-way communication must be facilitated so that operators can give immediate feedback to the management on how the procedures work. The operators must also receive confirmation that their feedback

has been acknowledged. There must be a short time interval between operator feedback and adjustments, or at least acknowledgement of the feedback. This does not mean that any comment from an operator should result in immediate adjustment of the procedure in question, but that the management reviews and acknowledges the feedback from the operators.

4.4 Paper 4: Optimizing of program for training employees in using Safety Management Systems in the petroleum industry (Wold & Laumann, in review).

This paper presented results from two studies: A literature review of training in organisations, and qualitative interviews with 27 executives and operators in two different companies involved in gas and petroleum production on the Norwegian Continental Shelf. The purpose of this paper was to discuss and give advice about how staff training on Safety Management Systems can be optimised.

The two companies in this study (Company A and Company B) have not invested much in staff training when it comes to using the Safety Management System and the procedures. There was only a short web based course with a multiple choice test at the end with ten questions. It takes less than one hour to complete the course and the course is not repeated. A short training course with no follow-up is not only insufficient to learn how to use the Safety Management System properly, it also sends a signal that the management system is of less importance.

The first thing the two companies need to do is to make sure that the existing course is repeated and followed-up. A buddy system to ensure on-the-job training should also be rather easy to set up. In the long run, more profound changes in the training programme are advised. One should analyse the needs of the organisation, the specifics of the job-tasks and the persons involved. Then a training programme can be set up with a combination of theoretical and practical training, followed up with on-the-job training, workshop sessions and mental training to ensure repetition. This demands resources, but training should be seen as an investment in human capital, because multiple studies have shown that training improves organisational performance (Aguinis & Kraiger, 2009; Arthur, Bennett, Edens, & Bell, 2003; Salas & Cannon-Bowers, 2001; Sitzmann, Bell, Kraiger, & Kanar, 2009).

The content of the training is also important. It should be designed to give the workers an understanding of the purpose and the origin of the Safety Management System and the procedures, as it is clear that such an understanding has a positive

effect on the use of the system and the procedures. Knowing the basic structure of the Safety Management System and how to navigate it will be more serviceable for good use than trying to teach the operator to memorise tiny details. Training should also focus on the limitations of the system, and aim to avoid overdependence (O'Hara, Higgins, Stubler, & Kramer, 2000). Accordingly, training should also help workers to develop skills to know when and how to adapt the procedures to the immediate situation (Dekker, 2003; Wold & Laumann, 2015a).

5 General discussion

Safety Management Systems are here defined as IT-based systems whose purpose is to code and share good practices, create corporate knowledge directories and to create knowledge networks for the organisation. Good procedures and work descriptions are needed in any organisation operating in a hazardous environment, and these must be organised in a manner that makes it easy for the workers to find the procedures and checklists that they need when they need them. An IT-based Safety Management System is no doubt preferable to the old and time consuming arrangement that a few of the older informants referred to: a stack of ring binders with all necessary documents. An IT-based Safety Management System can give access to necessary governing documentation for all workers in a geographical dispersed organisation allowing for updates to be swiftly distributed. Several organisations operating in hazardous environments have found IT-based Safety Management Systems to be a convenient way to gather all governing documentation, not only for risky operations, but for all tasks, like procedures for writing time sheets and registering overtime, procedures for ordering new equipment, and so on. As a consequence the Safety Management Systems can become enormous and complex. With such an amount of information it is not the intention that the workers should know everything there is to know about the Safety Management System, and neither that they should remember detailed procedures by heart. The intention is rather that the workers should be familiar with the structure of the Safety Management System, so that they can easily navigate through it and find the information and procedures they need when they need them. Also for routine tasks and procedures that the workers are very familiar with, they can benefit from establishing the habit of using the Safety Management System on a daily basis, for instance for quality assurance with regards to technical and specific requirements. Of course one should strive to make the management systems and the governing documentation as intuitive as possible, and make sure that the design fits the characteristics of the users. However, user friendliness cannot be taken for granted, so proper training is essential.

The Safety Management Systems used by the two companies in this study are similar to each other. The systems are set up as intranets. Every employee has their own personal user account which they can use to log on the intranet from a computer at their work desk. There are also computers in the lounge area where the workers can access a reduced version of the management system without logging on. The management systems are organized in a hierarchic folder system. The employees start by clicking on one of the main folders, for instance "Administration" or "Operation and maintenance", which is the one that the informants mainly use. Every folder contains clickable icons denoting various areas of work, for instance "Hot Work Class B". Every click on an icon navigates the workers further down the folder hierarchy until they reach the exact work procedure or checklist that they need for the planned task.

The Safety Management System in both companies contain procedures for all tasks at all levels: for tasks at the sharp end, for ordering new equipment, for administrative tasks, for writing overtime etc. Operators and executives are expected to use the Safety Management System routinely to make sure they perform their given tasks according to official guidelines and company values. The analysis in this study focused on the operators' use of the Safety Management System.

There were a few common denominators among the informants that had good use of the procedures and the Safety Management System:

- They were able to say something about the purpose of the Safety Management System and the procedures.
- They saw the procedures as helpful in the daily work routine.
- They saw the procedures as a result of industrial experience accumulated over many years.

The common denominators among the informants who never or rarely used the Safety Management System were:

- They saw their own experience and competence as more important than the work procedures for safe practice.
- They could only give vague descriptions of the Safety Management System and the purpose of it.
- They thought the Safety Management System was mainly important for the management, and not so much for the operators.
- They thought it was difficult to use the Safety Management System, and preferred just to go out and do the job.

In the following, the main challenges of using a Safety Management System will be presented and discussed based on the theories presented in chapter 2, and other research on Safety Management Systems, and on analyses of the interview material from the two companies. Several of the challenges are related to communication and to the social and organisational context, like how the workers relate to computers, information overload, difficulties in dealing with highly detailed procedures, the development of informal procedures, the workers' ideals of professionalism, how to get a sound two way communication and to overcome language difficulties. This also relates to how staff training should be, how one should relate to violation or adaption of procedures, and the need for standardisation and flexibility. A revisit to the five approaches to safety presented in the theory chapter will conclude the general discussion. All quotes in italics are from the interviews in this study.

Although references will be made to research on the use of computer based procedures in other industries, the aim of the analysis is not to compare the Safety Management Systems to systems in other organisations or industries or to review guidelines from safety authorities. It is outside of the scope of this thesis, which is rather a case study on the use of Safety Management Systems in two organisations with particular focus on the communicational aspects.

5.1 A communicative challenge

Several of the challenges related to the way the communicative aspects concerning the Safety Management System have been underestimated, or even ignored. The onshore executives in this study regarded the Safety Management System as a tool. And as a tool it does not require interpretation, it just requires handling skills. But the Safety Management System should rather be regarded as a communication system with information being transferred mainly from the executive level in the organisation downwards to the operating levels. With the notion in mind that one cannot not communicate (Watzlawick et al., 1967), the use of IT-based Safety Management System also constitutes a form of communication. This opens up different perspectives about how the Safety Management System is being perceived and interpreted by different people in the organisations, and how this affects their use of it. In this perspective, using a Safety Management System is a cognitive process, not just a mechanical one. Communication is sometimes seen as a mere transmission of information, but this is an insufficient perspective as the information is not always received or understood as intended (Drottz-Sjöberg, 2012). The information in the Safety Management System is not necessarily understood and used by the operators as the management intended, because interpretation is always a part of the process of communication. Information is not merely transported from one person to the other, and different people interpret the same piece of information differently. A well-known phenomena within organisational communication is that the response and reactions from the staff often indicate that they have made different interpretations than the management expected (Bouwman et al., 2005). Several of the operators did not quite understand the purpose of the Safety Management System. They knew it was important for the management in the company, but did not know exactly why it was important.

A mutual understanding is an important contextual factor in any communication process, as one of the operators pointed to:

11: They have to tell us why we should use [the management system]. Because we are perfectly able to do our job without reading documents for an hour before we get started. (...) If the people who develops or organises this, are able to communicate to us why we should spend time on this, it might be more interesting for us when we understand the point of it.

The information is always interpreted, and factors like prior knowledge, experience, values, attitudes, and context impact how the information is interpreted.

Interpretation can mean a lot of different things. It can for instance mean that workers must interpret procedures with respect to a collection of actions and circumstances because procedures do not specify all circumstances to which they apply (Dekker, 2003). If an organisation imagines a linear transfer model of communication, they will miss out on the potential for different interpretations and misunderstandings. The communicative challenges cover a wide area of topics: the use of computers, the level of details in the procedures, information overload and development of informal procedures, ideals of professionalism, feedback, language, and the context in which the communication takes place.

5.2 Social and organisational context

In the attempts to find universal knowledge that applies to all organisations of a certain kind, one must also take into account the contextual factors in every organisation. Knowledge is always context dependent (Sohlberg, 2009). Context is a very wide concept, and can in this respect refer to organisational culture, how the employees relate to technology, language, and how the procedures are constructed. If one regards the Safety Management System merely as a tool, one runs the risk of failing to see the potential ambiguities of the system and how these ambiguities are being perceived and interpreted differently by different people in the organisation. Too often the social and cultural dynamics in an organisation have been ignored in the development and implementation of Safety Management System, with a focus mainly on the technical requirements (Alavi & Leidner, 2001; Cox & Cheyne, 2000;

Rai, Maruping, & Venkatesh, 2009; Vinodkumar & Bhasi, 2011). Thus, the concept of communication and interpretation has also been neglected, both in the safety science and in the energy industry (Wold & Laumann, 2015a).

Certain structures, like the social and cultural context, will guide communication (Hall, 2002; Morley, 1992). It can be useful to consider how people with different roles in the organisation might have different frames of references, different values, attitudes and language codes, and how this can guide their interpretation in different directions. Especially in geographically distributed organisations there is also a matter of workers having a very different work context, so they do not have the same sensory experience. One should also be aware that organisations are not necessarily in perfect harmony, and that there is no guarantee that all members of the organisation share a common belief about how the organisation's goals should be reached (Rasmussen & Lundell, 2012). Resentment towards the leadership can influence communication. Organisations have often tried to create a corporate identity to unify the workers at the different levels in the organisation, and to create a common sense shared by everyone in the organisation. The onshore executives in Company A talked about being a 'collaborative community' as one of their core values, and as something that demanded everyone to pull in the same direction. None of the offshore executives or operators in the same company made any reference to this collaborative community. It was also rather unclear what exactly the onshore executives meant when they were talking about the organisation being a collaborative community. They stated that it demanded employees agree with corporate, and that they had been given this in a formal protocol, that is, the Safety Management System, but could not say exactly what they had done to establish the idea of corporate community among the workers. This is one reason why the tool perspective on Safety Management Systems is insufficient. It is not enough to hand over the protocol to the operators and expect them to automatically follow it to the letter simply because they are supposed to. In doing so the management underestimates the ambiguities of communication and how the social and organisational context affects communication. In fact, there are a lot of contextual

factors to consider in any communication process. One of the factors is the medium used to hand over the protocols. The system is based on IT, and computers were not the favourite piece of equipment of the operators.

5.3 Dislike computers

One contextual factor that might seem banal but still matters is how new technology is appreciated by the workers. New technology in the workplace might be seen as something interesting to learn and as something making the work procedures easier, but can also be experienced by some as a threat to one's status if tasks are changed or 'taken over', or one might feel that it is difficult and just adds to the work load (Haddon, 2004). In order to understand and analyse how people use computer software, it is inadequate to see computer software merely as a functional technology (Valle, 2007). Computer technologies have meanings for people. The technology itself has an impact on how a piece of information is received and interpreted by the individual worker. Gas and petroleum producing installations are technology rich places, but workers still need time and training to adjust to new technologies, especially when it comes to computers and software technology that are not their first choice of equipment. It is quite possible that their dislike of computers has an effect on their interpretation of the Safety Management System and their use of it. Although executives and operators in both companies in this study were familiar with computers it was certainly not their favourite equipment. The operators preferred to 'just go out and do the job', as one of them phrased it, and did not always see the point of sitting in front of the computer first.

11: We are used to doing our job without having to use computers. So they have to explain why we should use it, give out information. Because we are perfectly able to do the job without having to sit for an hour reading documents before we start. They have to explain why we should go through all these documents. (...) Why should we sit here and read for an hour when we can just go out and do the job?

Other studies have also indicated that workers have a tendency to emphasise the importance of practical competence (Antonsen, 2009; Borys, 2009; Reiman, 2011). This is similar to the offshore operators in Dahl's (2013) study who would rather work

than sit in front of a computer, dismissing sitting in front of a computer as real work. This is a background factor that needs to be taken into consideration when developing a Safety Management System. Although Norway is a wired country where private households and work places are saturated with online technology like computers, tablets and smart phones, and although petroleum production is a technology rich industry, one should not take the operators' computer competence for granted. The onshore executives who were in charge of the development of the Safety Management System in Company A said in the interviews that they expected the workers to be proficient in computer usage, and hence, user friendliness and training was not given priority. Judging from the interviews with the workers in the same company, it seems that the developers have overestimated the worker's level of computer proficiency, because the workers found the Safety Management System very difficult to use. The level of computer competence of the workers must be taken into account when developing a Safety Management System to ensure a good level of user friendliness. The same considerations must be done when designing the training programme. Dislike of computers can be a demotivation factor that must be taken into account and dealt with. Dislike of computers may also have an effect on a related factor; many of the informants found it difficult to navigate through the vast amount of procedures to find the one they needed.

5.4 Information overload

A well-known challenge in safety science and in the high risk industries is the growing number of procedures. This is partly due to the complexity of work and a desire to make the procedures as realistic as possible, but also because new procedures can serve as a visible way of demonstrating vigour and satisfying regulatory authorities in the aftermath of accidents or other unwanted incidents (Antonsen et al., 2008; Dekker, 2003). As a result, the amount of procedures can appear as a jungle where it can be difficult to locate and choose the right procedure (Alavi & Leidner, 2001; Antonsen et al., 2008; Grote et al., 2009; Wold & Laumann, 2015a). Having too many and too detailed procedures can be counterproductive. Similar to an information overload scenario, a procedure overload can make it

difficult to keep track of the different procedures, and can even make it tempting to deliberately violate the procedures. Overdesigned rules are also the ones that get violated most often, and might also reduce flexibility (Grote et al., 2009; McDonald, 2006; Oltedal & Engen, 2011; Sutcliffe 2011). The informants found it tedious to flip through a lot of information, and though it was difficult to find the necessary information.

6: When I was going to delve into the management system, I just went in circles. It was like an everlasting loop, which I didn't understand anything of. I flagged it to the system operator, and he admitted... At first, he said that this was crystal clear. So I asked him to try it himself, and he did. And he too ended up going in circles.

The amount of information in the Safety Management System was also a recurring topic in the interviews. We tend to ignore or disregard a lot of information that we consider to be irrelevant for us. The individual constantly performs some sort of classification of the information. This might be done unconsciously during daily routine, but can also be the result of deliberate consideration as to whether this piece of information looks useful. These considerations might be more or less flawed, particularly when several work processes need to interact with one another. An organisation will create a large number of rules and procedures if they try to have procedures for every possible situation and condition that might occur. The informants in this study would prefer to relate to a fewer number of procedures and thought that unnecessary procedures took their attention away from the important ones.

13: There are many procedures here that aren't relevant for me. (...) I just hope they don't create a chaos of procedures. That you deal with as few procedures as possible, but that all those procedures are relevant for the work that is actually being done on the installation. So you don't get a procedure for how to write new procedures. And a procedure for how to put your shoes on. That's just stupid. Because it distracts attention away from the procedures that are actually important and necessary.

A large number of rules and procedures can make it difficult to navigate the Safety Management System and to know which rules and procedures to activate for a specific scenario (Alavi & Leidner, 2001; Antonsen et al., 2008; Dekker, 2003; Oltedal

& Engen, 2011; Sutcliffe, 2011). A common reason for violating procedures is that the total amount of procedures is difficult to handle (Antonsen, 2009; Dahl, 2013). Keeping the procedures few and simple and reducing complexity can be important strategies to increase adherence to procedures (Antonsen et al., 2008; Reiman, 2011). This relates not only to the amount of procedures, but also to how much detailed information each procedure contains. Reducing the number of procedures can be one step towards reducing the risk for cognitive error, and for creating a user-friendly system.

5.5 Detailed procedures

Procedures are often constructed as means for standardisation and barriers in order to constrain performance, and this control aspect of procedures often means to protect from human error. This can in turn lead to procedures that are very detailed. Detailed procedures are the ones that are violated most often (Dahl, 2013; Reiman, 2011), and operators painstakingly following rules without sensitivity to context can get blamed for their lack of flexibility (Dekker, 2003; McDonald, 2006). It is also argued that this way of designing procedures as constraints on human action relies too much on an explanation of accidents as a linear combination of failures and malfunctions, and that procedures should rather be seen as resources to facilitate individual decision making (Antonsen et al., 2008; Dekker, 2003; Haavik 2010; Hollnagel, 2009; Reiman, 2011; Schuman, 1987). Less extensive and less rigid rules and procedures leave more space for the operator to decide exactly how a specific task should be performed (Bourrier, 1996; Howard-Grenville, 2005). One of the informants had the impression that there had been a development toward less detailed procedures, something he thought could be both an advantage and an disadvantage.

24: There are two sides to it. It was practical to get everything served on a plate, so to speak. For us operators, when we're working on an installation, it can be alright to get very detailed work descriptions, but at the same time it is good to have some room to think. Or to have some leeway inside the given framework.

Rules and procedures can function as facilitators helping people to structure activities during daily work routine and to make a professional evaluation about how to adapt the procedures to the immediate situation. However, some procedures must be rigid, for instance procedures for tasks that are performed rarely, or are complex, require coordination between several units of the organisation (Antonsen et al., 2008).

The informants from Company B in this study, who were contract workers with experience from different offshore installations, said that the standardisation made it easier because procedures now were the same on different installations. On the other hand, when the formulations in the procedures are a bit more open, allowing for different interpretations, they found that the same procedure was interpreted differently on different installations within the same company, as this informant gave an example of.

26: As for our tools, in some places we can have our angle grinders the way we prefer. Other places we can only have the angle grinders with a stop button, so if you release the button, the grinder stops. (...) On some installations we are allowed to lock up that button.

It is impossible to write procedures to cater for any change in circumstances in a dynamic workplace, so one should train the operator at adapting (Antonsen, 2009; Dekker, 2003), and enable them to switch from following shared rules to adaptive operations, where the operator selects and develops new rules that are adapted to the situation (LeBot & Pesme, 2014). For any of this to happen, it is crucial that the operators know and understand the basis and the purpose of the procedures (O'Hara et al., 2000). If procedures are too detailed, adding to an information overload, it can be tempting for the operators to find alternative, informal ways of doing their job.

5.6 Informal procedures

If the operators find the official procedures too bothersome to deal with, there is a chance they will develop a set of informal procedures. Informal procedures are often hidden from the management, and can erode the managerial control (Antonsen,

2009; Antonsen et al., 2008). One informant had a private list of how tasks were done, and did not use the official procedures at all.

16: Well, I know that for every separate task I'm going to do, there are different... I have a cookbook that I follow.

I: Which procedures do you use?

16: I have no idea. I don't know where it is filed. (...) I have my own way of doing things.

Over time, violation of procedures can become routine, a part of 'the way we do things around here'. The operators in Company A had created a few solutions themselves to deal with the Safety Management System. Some of the operators had printed out a pile of checklists, so that they did not have to go back to the Safety Management System and find a new one for every job. An obvious drawback with such a solution is that they do not get the updates if there should be any changes in the checklists or procedures. The informants themselves acknowledged this drawback, but still found it to be the more practical solution. Another solution of the workers' own design was a specially made web page with links directly to all the documents they used on a regular basis. The management of this organisation discovered this web site, and closed it down. A different, though more resource demanding strategy when workers are doing their job in a different way than described in the procedures, could be to investigate whether they are doing it in a better way than described in the procedures, or if they are taking unnecessary short cuts and risks. This also relates to the ideals of professionalism as part of the organisational culture.

5.7 Ideals of professionalism

Violations of procedures can be a result of peer pressure in the organisational culture, where using informal procedures can function as a sign of competence and expertise. Several studies have indicated that workers have a tendency to give higher value to practical than theoretical competence (Antonsen, 2009; Borys, 2009; Reiman, 2011) and to be able to use their own judgement instead of just following rules

(Hollnagel, 2009; 2004; McDonald, 2006). In a study with a number of surveys done in different organisations, McDonald (2006) identified some core professional values of aircraft maintenance personnel. Most importantly in this respect was that the maintenance personnel gave high value to being able to use their own judgement and not just following rules, and to being confident in one's own abilities to solve problems (McDonald, 2006). There were also several studies showing that maintenance personnel consider the knowledge of how to interpret, apply and neglect the procedures in a manner that work can be carried out as thoroughly and as efficiently as possible as a key part of their professionalism (Hollnagel, 2004; 2009; Reiman, 2011). Procedures that are perceived as unnecessary can also function as a disparagement of the workers' competence, as this operator gave evidence of.

13: They had a procedure for how to use personal protective equipment, boiler suit, gloves and helmet. They had a special procedure for it. And it basically said that you should always wear it during work outside. And it's just a disclaimer of liability, as I see it, and a way to reduce intelligent workers to stupidity.

Often adaptation and interpretation of rules is considered an integral part of the work (Reiman, 2011). A Norwegian study showed how a group of aircraft line maintenance technicians valued procedures, rules and regulations as guides for work practice, but at the same time, they distrusted them, and sought to adapt their practises depending on the situation (Pettersen & Aase, 2008). This way of being able to outsmart hierarchical control and compensate for higher-level organisational deficiencies or ignorance can become a part of one's professionalism (Borys, 2009; Dekker, 2003; Hollnagel, 2009; 2004; McDonald, 2006; Reiman 2011).

Some of the informants in Company B said that experience was necessary in order to know how to do the job properly.

27: The management system can't tell you that, but it is based on experience, like "shouldn't we do it like this instead, to be 100 per cent sure", you know. Based on experience, really.

The operators in Company A in this study felt that they did not really need the Safety Management System because they knew how to do their job.

15: Well, when you've worked a number of years in the North Sea it's kind of in your fingers, so to speak. You know the regulations; you know what you have to deal with. You know the system so well that you only have to use it to do very special operations.

They saw the Safety Management System as a way for the management to make sure that all paper work was in order, and to make sure that the less experienced workers did not mess up, or as one informant laughingly put it: 'it is to keep the idiot safe'.

This does not mean that they ignore safety. Doing the job safely can be regarded as a part of one's professionalism, and as an important ingredient in competence (Wold & Laumann, 2015b). Using procedures and the Safety Management System can be seen as part of this professionalism, and as Reiman (2011) also pointed out, the contextual development of competence, responsibility and professionalism should be clarified in future research.

With Dekker's (2003) notion that safety results from being skilful at judging when and how to adapt procedures to a given situation or circumstances in mind, it is possible to establish the concept of using and adapting formal work procedures as an integrated part of the ideals of professionalism. Organisations operating in hazardous environments should aim to establish a link between using formal work descriptions and how to adapt procedures to local circumstances with the ideals of professionalism. The professional experience of the workers is not to be underestimated, and can be valuable in further development of the procedures, and they should be encouraged to report inaccuracies and near misses. For this to work out, good two-way communication is necessary.

5.8 Two-way communication and feedback

A communication process must be two ways. Most of the communication in a Safety Management System is one way, with messages moving from the upper tiers of the organisation to the lower tiers, but there should be feedback as well. In a hierarchical organisation it is natural that most of the information passes from the upper tiers to the lower tiers, but there should also be feedback from the lower to the upper tiers. Lessons learned at the operative level can be transferred to the management and

taken into consideration. For instance, when the operators face a problem, it is useful to record the nature of the problem and how it is being dealt with.

In Company A there was a possibility in the Safety Management System to write comments about the specific procedure. Some of the operators were not aware of this. The ones that had written comments had not always gotten any feedback on their reports.

6: I haven't gotten any feedback on the reports I have made. Or, I have, in the start I got feedback when I made a report, but on the last three or four reports I've made, I heard nothing.

The few that had actually written comments had not been given any confirmation that their comment had been received or appreciated. After that they had not bothered to give any more feedback. In Company A only a few persons were responsible for handling such feedback, and it seemed as if they had other responsibilities that were given greater priority. When feedback is given, the time interval before implementing changes should be as short as possible (Antonsen et al., 2008; Bourrier, 1998; 2005). This feedback and response are also a way of letting the operators know that they are being involved in the development of the procedures, which will serve to give them a sense of ownership regarding the procedures.

When a single or a group of individuals routinely perform certain tasks, they will over time develop an experience and a feel for how to make intuitive judgements on how various tasks should be performed. This constitutes an important part of the tacit knowledge in an organisation, which is local and situational knowledge (Alavi & Leidner, 2001; Almklov et al., 2014; Choo, 2001; Sohlberg, 2009). This tacit knowledge can over time cause the organisation to go into an operational drift where nobody is able to give a formal account for exactly how things should be done. But tacit knowledge constitutes accumulated experience which can be an asset for the organisation if one is able to bring forward this experience and make it available for others (Haavik, 2010). A Safety Management System constitutes an attempt to formalise and systematise the tacit knowledge and experience in an organisation. For

this to work there must be feedback from the lower to the upper tiers of the organisation, so that procedures can be adjusted according to the view of those who actually use the procedures (Antonsen et al., 2008; Bourrier, 1998; 2005). In this way procedures can be based on a combination of standardised theoretical knowledge and practical experience. This is relevant also for small adjustments, such as grammar, abbreviations and phrases used, to make sure that the end users clearly understand the language used.

5.9 Language

One should pay careful attention to the language used in the Safety Management System. It is not unusual that individuals at different levels in an organisation tend to use different words and grammar. This is partly because they have different socioeconomic backgrounds and education, but also because they work in different social environments. Some of the informants in this study thought that the language used in the Safety Management System was a bit difficult, with phrases and words that were unfamiliar to them. Both operators and offshore executives mentioned trouble with the language used in the management system. One of the more specific complaints the informants had concerned the language used in the Safety Management System. They would prefer it to be in Norwegian and not English.

8: There's a lot of words and expression that might be unknown to us because it's in English. I think the user friendliness would have been better if it was in Norwegian.

They also thought it was a bit 'academic' English, with some difficult words and grammar they were unfamiliar with, and thought it was a way for the management to show off.

18: Maybe it's a bit difficult because it's in English. Of course it's not a problem to understand English when it's normal English, but there's a lot of expressions that are a bit tricky.

Language is essential for communication, but equally important is the fact that language, as Bradd Shore stated, is 'perhaps our greatest tool for modelling reality' (Shore, 1998, p.11). Shore continued to state that anything that we hope to

understand clearly and to communicate to others has to be modelled in some form. It is easy to take our language and its meaning for granted, but in fact, there are many ways in which language models the experience for us, and even tiny elements in the language can bear diverse meanings, like vocabulary and grammatical forms (Shore, 1998). Certain words or codes in a language community or culture can be so widely distributed that they appear as naturally given for the members of this language community (Hall, 2002). One can easily forget that not necessarily everyone belongs to the same language community just because they speak the same language. The workers must understand the language used. If one does not understand the language, one cannot understand the content of the procedure. So wording should be clear and unambiguous, where the same wording is used for similar tasks. Extensive use of abbreviations should be avoided. Proper training is also instrumental in order to be sure that everyone understands the words and concepts used in the Safety Management System.

5.10 Training

All people concerned must be given careful introduction to new work systems (ISO 6385:2004), because there is a correlation between employees' training and successful implementation of Safety Management Systems (Bottani et al., 2009; Vinodkumar & Bhasi, 2010). Still, several studies referred to by Dahl (2013) revealed that the actual knowledge of rules and procedures varies considerably among workers, and that this is often due to a lack of formal training on how to use the procedures and the Safety Management System. This lack of formal training can also often be interpreted by the workers as a signal that active use of the safety management system is not essential (Dahl, 2013).

Workers in both companies in this study underwent a short web based introductory course to the Safety Management System, with a multiple-choice test at the end where they must get 8 out of 10 points to get a license to work on the offshore installation. They can take the test as many times as they need. Each worker goes through the course individually. The course does not include any simulation or practical exercises, and is not repeated. The only follow-up is in Company B where

rookies were teamed up with more experienced workers for their first period on the offshore installation, but mostly it was learning by doing. Several of the informants said they would like to have more practical training.

10: I think it would be better to have some group assignments. And to have a specific task to solve. (...) Now it was just demonstrated in the class room with someone pushing buttons on a screen. In my experience I find it better to push the buttons myself than to watch other people pushing buttons.

All the informants in both companies said that they had to 'fiddle about with it for a while' in order to get familiar with the Safety Management System and to be confident in using it. This fiddling about takes place during their normal working day when they have specific and highly safety regulated tasks to perform. It is difficult to learn how to use such a complex system only through theoretical exercises. All the informants in both companies said they would prefer more practical training. Related to the need for practical training is the need for repetition. Neither company had a formalised repetition of the training, which some of the informants commented on.

18: Generally with these kinds of systems you will, or at least I benefitted more from such courses a bit later. I understand that you need a certain introduction before you can start using it, but it is also very helpful to have the course afterwards. Because that's when the questions start to pop up, when you have started to use it.

A repetition of the course after a period of practical use would probably help the workers in getting a combination of practical knowledge and theoretical understanding of the management system and the procedures. A knowledge-based understanding is needed to properly follow procedures and to be able to interpret and evaluate the procedures according to the immediate situation (O'Hara et al, 2000). To invest in people's knowledge of procedures is important for progress on safety (Dekker, 2003). Training should not only focus on knowledge of and proper use of procedures, but should also focus on limitations of the system and aim to avoid overdependence (O'Hara et al., 2000), so that they can adapt the procedures when necessary.

5.11 Violation or adaption of procedures

A prerequisite for the governing documentation to fulfil its purpose is that the members of the organisation actually pay attention to them, but several studies have proven that people do not always follow procedures (Antonsen, 2009; Dahl, 2013; Dekker, 2003; Lawton, 1998; McDonald, 2006; Rasmussen, 1997; Reiman, 2011). Violations of procedures can be defined as deliberate deviation from the written rules (Lawton, 1998), and in order to avoid this, it is important to understand the reason for the violations. Common reasons for violating procedures are often well-intentioned desires to get the work done, or to get it done faster, or that the procedures are not working properly, or that the sheer amount of procedures makes it difficult to handle them all (Antonsen, 2009; Dahl, 2013; Lawton, 1998; McDonald, 2006; Rasmussen, 1997). Violation of procedures can also be a matter of peer pressure, and that unofficial and quicker action can function as a sign of competence and expertise (Antonsen, 2009; Dekker, 2003; Lawton, 1998; McDonald, 2006; Reiman, 2011). Over time this can develop into an unofficial rule book of informal procedures, which in turn can lead to unsafe practice (Antonsen, 2009).

When workers are doing their job in a different way than described in the procedures, one could also investigate whether they are doing it in a better way than the procedures prescribe, or if they are taking unnecessary short cuts and risks. The procedures are usually developed by experts who do not experience the use of the procedures at the operational level (Antonsen, 2009). Various ways to receive feedback from the lower to the upper tiers of the organisation is an important feature in the further development of the Safety Management System (Antonsen et al., 2008). They are living systems, and the views of the workers directly involved in using the procedures should form the basis of experience that lead to the further development of the interaction between humans and the system (Wickens et al., 2004).

It can be tempting to trust that the procedures are perfect and simply increase pressure to comply, but organisations should rather investigate the gap between procedures and practice, and train the operators at adapting (Antonsen, 2009; Dekker, 2003). One way of thinking about adaption is that procedures represent the

best thought-out and safest way to carry out a job, and safety comes from people following procedures in a simple rule-based activity (Dekker, 2003). Dekker demonstrated that this view is problematic as it falsely presupposes that procedures can be written to cater to any change in circumstances in a dynamic workplace (Dekker, 2003). Using procedures is not just about motoric skills, but also about cognitive skill (Dekker, 2003). In order to operate safely it is necessary to be able to adapt the written procedures to local and immediate circumstances, and to change into adaption mode when an unexpected situation arises. Knowing when and how to adapt procedures to immediate circumstances is important for safe conduct (Dekker, 2003; Lebot & Pesme, 2014; Weick et al., 1999). The operator must always make qualified judgements. It is not only a matter of choosing and finding the right procedure. The operator must also fill in gaps and evaluate and compensate for inadequacies in the procedures, and must sometimes find more practical strategies than those described in the procedures. In some situations, following all the procedures to the letter can lead to an inability to get the job done (Dekker, 2003; LeBot & Pesme, 2014; O'Hara et al., 2000; Reiman, 2011).

This also relates to how the procedures are designed. Procedures have a tendency to become increasingly restrictive as they are often modified to prohibit actions that may lead to hazardous situations (Antonsen, 2009). An excess of very detailed rules can lead to an unresolved tension between effective planning and the requirement of flexibility, and if workers are painstakingly following the rules without sensitivity to context, they can get blamed for their lack of flexibility (Dekker, 2003; McDonald, 2006). It is probably impossible to design procedures to anticipate all the situations and conditions that shape the work, and if one attempts to do so, one is likely to end up with a very complex system of rules and procedure at the cost of the operator's flexibility (Oltedal & Engen, 2011; Sutcliffe, 2011). Standardisation can also lead to an over-reliance, meaning that the workers trust the standardised procedures blindly and never question whether this really is the best way of doing the job (Grote et al., 2009). Hence, it is important to balance the need for standardisation and the need for flexibility (Grote et al., 2009; McDonald, 2006; Sutcliffe, 2011). But how detailed

should procedures be? There is no general answer to this. Earlier analysis has concluded that it depends on the nature of the task involved. Detailed descriptions can be necessary for tasks that are either performed rarely or are very complex, while more general requirements will be sufficient for routine tasks (Antonsen et al., 2008).

Adaption requires that the management trusts the individual's ability to take initiative to adapt in a given situation (LeBot & Pesme, 2014). Routines come to life when they are being enacted by people, and this enactment process must allow for variation and change in the routine. This is taken into account by the concept of flexible routines (Howard-Grenville, 2005). Through flexible routines, or routines that deliberately allow for more 'space' in their usage, such systems could emphasise distinctiveness as well as responsiveness, and may provide means for dealing with uncertain and complex situations flexibly but safely. In this way one can switch from following shared rules to adaptive operation where the workers select, develop and validate new rules that are adapted to the situation (LeBot & Pesme, 2014; Rasmussen, 1997). For any such adaption to work out properly, it is important that the workers meet the high-level goals, not only the short term goals. For this to happen, the workers must have an understanding of the basis of the procedures and the higher-level goals (O'Hara et al., 2000). Several studies have also shown how it is possible to establish a professional climate where operators both value the rules and procedures as guidelines, and distrust them at the same time, seeing it as part of their professionalism to interpret and adapt the procedures to the situation (McDonald, 2006; Pettersen & Aase, 2008).

5.12 Five approaches to safety and Safety Management Systems

In the theory chapter, five approaches to safety were presented: NAT, HRO, Resilience Engineering, Drift into Failure and Communication. What can these approaches offer to Safety Management Systems?

5.12.1 NAT

NAT states that accidents will occur in the normal course of operation for any organisation that operates high-risk technologies (Lekka, 2011; Perrow, 1984; Weick

et al., 1999). This is because the elements in these organisations are tightly coupled with a high degree of interdependence and complex interaction. This makes the interaction unpredictable or invisible. As tight coupling calls for a central organisation and interactive complexity calls for decentralised organisation, both requirements cannot be met at the same time and the result is that accidents are inevitable (Perrow, 1994). But a Safety Management System is in fact an attempt to combine these two requirements. Safety Management Systems represent a centralised organising, but leave room for decentralised decision making by having flexible procedures allowing for adaption to the immediate situation. The system should be designed to provide a framework for a central management that coordinates the interactive elements, while the procedures open up for local, situational adaptations and adjustments.

5.12.2 HROs

According to researchers within HROs it is possible for organisations to operate complex technologies in high-risk environments almost error-free. These organisations are tightly coupled with high interdependence among the components, and sequences are rapid and difficult to interrupt (Hopkins, 2007; Lekka, 2011).

The five main characteristics of HROs can all be linked to how a Safety Management System is supposed to work. (1) Safety Management Systems should have a built-in function for error-reporting, which are important in HRO-thinking as errors and mishaps can be important signals about which part of the systems might be vulnerable. This also builds resilience, as it helps the organisation to learn from mistakes. (2) When operators are given proper training and understand the fundamental ideas of the Safety Management Systems this can avoid a simplification of processes. (3) All employees, including operators at the sharp end, should have an understanding of the bigger picture to understand how their actions are connected with other parts of the organisation and how the Safety Management System serves this purpose. (4) In accordance with the acknowledgement that it is impossible to design procedures that can foresee any possible situation, one should rather design procedures that allow experienced operators to adapt the procedures to the

immediate situation. (5) This facilitates deference to expertise where decisions are taken by individuals with the relevant expertise regardless of their position in the hierarchy.

5.12.3 Resilience engineering

Resilience engineering is comparable with HRO research with its focus on the ability of a socio-technical system to monitor and cope with normal variability in human, organisational and organisational performance. A well designed Safety Management System can help an organisation to obtain the four main abilities identified as fundamental to resilience. At the same time, resilience engineering provides some clues as to how a Safety Management System should be designed: (1) The system should contain a prepared set of responses and procedures that allows for adjustments in order to absorb strain and preserve functioning in spite of adversity. (2) It should facilitate the monitoring of what is happening in the environment and in the performance of the organisation. (3) In continuation of the monitoring, the Safety Management System should offer means for systematisation of this information, helping the organisation to identify patterns of, threats and opportunities. (4) It should provide means to help the organisation recover from accidents and mishaps, and to record the experience in order to learn from the events.

According to the resilience perspective, for a successful design of a Safety Management System one should not place all emphasis on strict procedures. Safety is rather achieved through human processes and relationships that enable the system to handle and to learn from unforeseen events, and also to learn from success. It is also important to find the right balance between standardisation and flexibility when designing the rules and procedures. The Safety Management System should also include an easy-to-use built-in function for the reporting of errors and near misses.

5.12.4 Drift into failure

Adaptions and modifications of procedures occur all the time. There will be many work situations that leave many degrees of freedom for the individual operator to decide the details of how a task should be performed. Dekker (2011) and Rasmussen

(1997) have explained how these decisions can grow into an unreflective routine that over time leads to a systematic drift of organisational behaviour towards the boundaries of safe operation, or in other words, a drift into failure (Dekker, 2011; Rasmussen, 1997). To avoid this, one should investigate how the system operates and organises the technology, and enables the organisation to keep many interrelated components in a state of dynamic equilibrium (Dekker et al., 2008). In this respect, it is important that the procedures in the Safety Management System are designed in a manner that makes the boundaries for safe operation explicit and known among the workers. This will help the workers to be able to adapt the written procedures to the immediate situation without crossing over into unsafe practice.

5.12.5 Communicational aspects of safety and Safety Management Systems

NAT, HRO, Resilience Engineering and Drift into Failure all relate to communication and emphasise that safety critical information must be communicated through various channels. The four approaches advocate a just culture where near misses and accidents can be reported without fear of punishment, and that all warning signals are systematically collected, and that the outcome of the investigations of accidents and near-misses are communicated openly (Lekka, 2011). This involves a learning culture where information is communicated and shared effectively across different departments or shifts, and also across hierarchical levels within the organisation (Lekka, 2011; Norwegian PSA, 2004). Communication is important for all aspects of safety in an organisation, and the Safety Management System can be seen as an attempt to systematise this communication. Safety Management Systems should not be regarded merely as tools, but as communication systems. When the worker uses the Safety Management System he or she interprets the content according to his or her prior knowledge and experience. Using a Safety Management System is a cognitive process, so one should emphasise the cognitive characteristics of humans and how people interact with technology. The context in which this interaction takes place matters a great deal.

Context is not only the physical environment, but is also related to organisational culture, frames of references, mental schemes, knowledge, values and attitudes

among the employees and the management. One context factor can for instance be that the workers do not always focus on written procedures but prefer to start working immediately instead of sitting in front of a computer, as was the case in a study of Norwegian offshore workers (Dahl, 2013). The informants in Dahl's study talked about 'real work' versus 'sitting in front of a computer' as if using a computer did not count as 'real work'. Any communication opens up for misunderstandings, so this perspective has consequences for how the procedures should be constructed, for staff involvement and for staff training. In an organisation there will always be some structural differences between the different levels, due to different educational and professional background, experience and culture. Misunderstandings or distortions in the communication process between different levels in an organisation are often partly a result of these structural differences (Hall, 2002). This has not only to do with the hierarchical structure, but also with different frames of reference which are important for any interpretation. In any culture, also a business culture, there will be some values and ideas about the world that are more or less taken for granted. Professional organisations have often tried to create a corporate identity to unify the different levels in the hierarchy and to create an organisational common sense in order to avoid misunderstandings (Bouwman et al., 2005).

People with a different work context will develop different mental schemes and tacit knowledge, which again can lead to misunderstandings in the communication process. In a geographically distributed organisation it can be a challenge as the workers have very different work contexts and do not share the same direct sensory experience. There have been several cases where experts, being extremely familiar with the system they are designing, fail to predict the difficulty that other people who do not have the same frames of references will have when trying to interact with the system (Norman, 1998). Likewise, onshore workers do not have the direct sensory experience and tacit knowledge that offshore workers gain when working on the installation, which can result in a lack of awareness of offshore processes among onshore workers (Andersen, 2013). These are context factors that must be taken into consideration. Therefore it is important that all communication is unambiguous, and

that proper training is given to all staff members to create a sort of organisational common sense, a fundamental knowledge structure shared by the entire organisation.

In accordance with this perspective, methods and principles from human factors should be applied in predesign analysis, technical design, and final test and evaluation of Safety Management Systems. This way, many of the human factor deficiencies will be avoided before they are inflicted on system design (Cox & Cheyne, 2000; Deacon, Amyotte, Khan, & MacKinnon, 2013; Wickens et al., 2004). One must clarify who the users of the system are and what their preferences or requirements for the system are, what the main functions of the system should be, and the conditions under which the system will be used (Wickens et al., 2004).

6 Summing up and conclusion

Safety Management Systems are integrated mechanisms in the organisation whose purpose is to keep the workers safe, to help the organisation meet the regulatory requirements, to accumulate and distribute knowledge and good practices, and to help the organisation as a whole to learn from experience (Antonsen et al., 2008; Bottani et al., 2009; Chen & Chen, 2012; Dekker, 2003; El Koursi et al., 2007; Hale et al., 1997; Norheim & Fjellheim, 2006; Santos-Reyes & Beard, 2009; Vinodkumar & Bashi, 2011). This also means that a Safety Management System is never completely finalised, but should be continually developed, and that feedback from the people who use the system and the procedures on a regular basis should be a part of this development.

The four research questions that have been formulated in this dissertation can now be summed up.

- 1:** How is Safety Management System defined in the safety literature?
- 2:** How is Safety Management System used in a petroleum producing company?
- 3:** How can end user involvement improve the development and use of procedures and Safety Management System?
- 4:** What kind of training in the use of procedures and Safety Management System are the workers in two different companies given? How can the training be improved?

6.1 How is Safety Management System defined in the safety literature?

In both the academic literature and in the industry these systems are given different terms, with Safety Management System, Information System and Knowledge System being the most common ones. The systems are described as IT-based superstructures, or umbrellas, containing procedures, checklists and descriptions on how different tasks should be performed, and what kind of safety standards different tasks require. I found it best to use the term Safety Management System, and to define it as an IT-

based system whose purpose is to code and share good practices, create corporate knowledge directories and to create knowledge networks for the organisation.

The challenges with using IT-based Safety Management Systems are quite similar to the challenges of using procedures including time pressure, lack of flexibility, and a sense that there are better and quicker ways to get the job done. This is also linked to the workers' image of themselves as professionals. A lack of flexibility and information overload can also lead to situations where the workers are not able to interpret the procedures and adjust them to the situation at hand. In most of the papers, Safety Management Systems are simply regarded as tools, but they should rather be regarded as communication systems. By analysing this as a communication process one can identify the various understandings or misunderstandings that might occur when the worker interprets the information in the Safety Management System and turns it into knowledge, adding his or her prior knowledge and experience. The cognitive strengths of humans must be emphasised, but also how operators interact with management systems and procedures. Not only must machines be designed to suit the physical abilities of the expected user, but training, instructions and procedures must be designed to fit the cognitive processes in the human being.

6.2 How is Safety Management System used in a petroleum producing company?

The executives and workers understood the management system very differently. While executives perceived the management system as a fundamental tool for safe conduct, the attitude among the workers was that they can do their job properly without the Safety Management System. The workers acknowledged the need for safety measures, but they did not see how the Safety Management System was supposed to ensure safety. Most operators could only give vague descriptions of the Safety Management System. They said it had something to do with safety, but most of them were not able to explain exactly how the Safety Management System would increase safety. They saw their own knowledge and competence to do their job properly as more important for safety than the Safety Management System. The

informants who were able to say something about the purpose of the Safety Management System had a much better use of it than those who could not. The key to such a development lies in proper communication and training. The training should focus on meaning to make sure that the users understand the purpose of the Safety Management System, and aim to establish the ability to apply and adapt procedures with good judgement as a part of the workers' professional identity. To better match the user interface to the workers, a user analysis is necessary to identify the different types of users and how the systems and procedures should be designed in order to be a resource for the users. The users must also be allowed to give feedback on their experience with the different procedures.

6.3 How can end user involvement improve the development and use of procedures and Safety Management System?

The informants who had to some extent been involved in the development of the procedures had a feeling of ownership regarding the management system, while the ones who had not been involved at all felt no ownership towards the management system, and they did not understand the purpose of it. End user involvement in the development of procedures demands resources, but can be beneficial. This will help to create a feeling of ownership towards the system and an understanding that it is based on the practical competence and experience of operators. End user involvement can also help to bring forward tacit knowledge in the organisation and make invisible work processes visible and transparent. This can be useful in the further development of the system and adjustments of the procedures. For this to happen, two-way communication must be facilitated so that operators can give immediate feedback to the management on how the procedures work. The operators must also receive confirmation that their feedback has been acknowledged. Human factors offer valuable concepts to analyse this process. Human factors emphasise the importance of the user, and deal with other factors including the communication and cognitive processes involved in using the Safety Management System (Wickens et al., 2004). Broad and direct worker participation in the process of implementing the procedures has been shown to lead to a greater level of commitment and adherence

to procedures (Antonsen et al., 2008; Wold & Laumann, 2014). It will have a positive effect on the employee`s use of the procedures when they get the sense that the procedures have originated from themselves.

6.4 What kind of training in the use of procedures and Safety

Management System are the workers in two different companies given? How can the training be improved?

The two companies in this study gave their workers a web-based introductory course to the Safety Management System. The workers go through the course alone, and must score at least 8 points on a 10 question multiple-choice test at the end of the course. They can take the test as many times as needed. The course is not repeated or followed-up in any systematic way. This is not sufficient to learn how to use the Safety Management System. One should analyse the needs of the organisation and the specifics of the job-tasks and the persons involved. Then a training programme can be set up with a combination of theoretical and practical training, followed-up with on the job training, workshop sessions and mental training to ensure repetition. The training should be designed to give the workers an understanding of the purpose and the origin of the Safety Management System and the procedures. The training should be constructed from a basic perspective that the Safety Management System is a communication system, not merely a tool. The training should focus on establishing an understanding of why and how the Safety Management System has been constructed in the first place, what the purpose of it is and how previous experience over many years has been accumulated. Training should help the workers to understand the limitations of the system, and to develop the skills needed to be able to evaluate when and how they should adapt the procedures to a given situation.

This should be done with a combination of theoretical courses and practical exercises. The theoretical introduction can be done with classroom training or web based courses. The content of the training is more important than delivery mode, so companies should choose the most practical one. For instance can web-based courses be practical for geographically dispersed organisations? Classroom training and

lectures can open up more dialogue based learning in a supportive environment, but can be inconvenient and costly to set up for geographically dispersed organisations. Practical training could be done with classroom training, simulations, workshops, or on the job training. On the job training can help to improve innovation and tacit skills and to establish communities of practice where the workers can use each other as learning resources (Aguinis & Kraiger, 2009; Salas, Tannenbaum, Kraiger, & Smith-Jentsch, 2012). Simulation training on a fully developed Safety Management System ought to be rather easy to set up, either as a web based course or as workshop sessions on the work site. Repetition will help the workers to get a combination of practical knowledge and theoretical understanding of the management system and the procedures, and will reduce skill decay.

A central subject for further research should be how the workers interpret and understand the procedures and the Safety Management System, how their interpretation affects how they use the Safety Management System, and how this understanding can be utilised when developing procedures and optimising staff training.

6.5 Scientific contribution and practical implications for safety

The main contributions for this thesis include a definition of Safety Management Systems, describing challenges with implementation and use of Safety Management Systems in an organisation and presenting how user involvement and training could reduce these challenges. In the following, the main implications from each paper will be summed up.

6.5.1 Literature review

The contributions of the first paper in this thesis were to discuss various concepts of Safety Management Systems and to formulate a unifying definition. IT-based Safety Management Systems were here defined as socio-technical systems containing procedures, checklists, documented experiences, best practices, and expert references. This paper introduced a perspective on the Safety Management System and the procedures as a communication system. This perspective has been little

developed in the gas and petroleum industry and the safety literature, where the tendency is to regard them merely as tools. When analysing the use of procedures in a company as a communication process it becomes important to investigate how the operators relate to the procedures and what kind of meaning they attribute to the procedures.

Common challenges addressed in the research literature were related to:

- The workers' ideals of professionalism,
- Procedure overload,
- Lack of flexibility.

Organisations must:

- Establish using Safety Management Systems and the procedures as an integral part of being competent and professional,
- Regard Safety Management Systems as communication systems,
- Give attention to the social and cultural facets of knowledge management,
- Focus more on the areas of human factors, communication and interpretation.

6.5.2 Safety Management System as communication

The second paper presented research on the use of Safety Management Systems in two different companies in the gas and petroleum industry. The paper described challenges with the use of Safety Management Systems in these two organisations, and how they should attend to these challenges.

The two companies in this study should:

- Regard safety standards and work procedures as a part of the communication within the organisation,
- Make sure that the workers understand the purpose of the Safety Management System,
- Not overestimate the workers' computer competence,

- Allow workers to give feedback about their experience with the different procedures, and give proper and swift reply to this feedback,
- Establish the ability to apply and adapt procedures with good judgement as a part of the workers' professional identity,
- Analyse the different types of users and how the systems and procedures should be designed in order to be a resource for the users.

6.5.3 End user involvement

The third paper analysed how end user involvement can improve the development of procedures and Safety Management Systems. The main findings presented in this paper were that the informants who had been involved in the development of the procedures had a feeling of ownership regarding the Safety Management System, and a better understanding of the origin and the purpose of the procedures.

Organisations should involve end users when developing procedures and management system in order to:

- Utilise the competence and experience of the workers when developing the procedures,
- Bring forward tacit knowledge in the organisation,
- Make invisible work processes visible and transparent,
- Create a feeling of ownership towards the procedures and management system,
- Establish an understanding that the procedures are rooted in the practical competence and experience of operators.

This requires a dynamic communication between workers, management and safety experts, and two-way communication must be facilitated. One should also be aware of the limitations with respect to the resources end user involvement demands, and the competence and experience workers should have in order to be able to participate in a development process.

6.5.4 Training

The fourth paper discussed how staff training can be used to deal with the challenges in papers one and two. It was based on a literature review and on the data collected in the two companies.

Organisations should:

- Conduct a training needs analysis, clarifying the needs of the organisation, the specifics of the job-tasks and the persons involved;
- Give all workers a combination of theoretical and practical training;
- Give theoretical introduction by classroom training or by web based courses;
- Give practical training by simulations, workshops, or on the job training;
- Make sure that training is repeated and followed-up;
- Set up a buddy-system to ensure on the job training;
- Make sure that training includes a focus on purpose and the origin of the Safety Management System and the procedures;
- Make sure that training includes a focus on the limitations of the system, and aim to avoid overdependence.

6.6 Further research

We need further research to investigate how procedures and Safety Management Systems should be designed in order to function as facilitators for workers during daily work routines. One area of focus should be how detailed procedures should be and how the procedures impact the operating conditions for the workers. What kind of restrictions should the procedures impose, and where can it be adapted? It can be fruitful to differentiate between different types of procedures and the nature of the task involved. It might be that procedures for more extreme or emergency situations should be more detailed than procedures for more ordinary work situations.

It is also necessary to investigate how procedures can be designed in order to balance the need for standardisation and the need for flexibility, and whether the same

procedures can be designed to fit all the different group of workers. Flexible procedures require skilled workers, so should novice workers use the same procedures as experienced workers?

Further research is also needed to investigate how training programmes can be set up in order to develop the workers' knowledge and understanding of procedures and Safety Management System, and how training programmes can cater to different types of workers with different types and levels of competence and experience.

Keeping in mind the communication perspective of Safety Management System one should also investigate how the organisational and social context affects the communication process, and how an organisation can create mutual frames of references, or a common knowledge base, among its members to facilitate communication.

7 References

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8 Appendix

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- Paper 1:* Safety management systems - definitions, challenges for use and recommendations for improvements. *Safety Science Monitor*, 19(1).
- Paper 2:* Safety management systems as communication in an oil and gas producing company. *Safety Science*, 72, 23-30.
- Paper 3:* End user involvement in the development of procedures and safety management systems. Paper presented at PSAM 12: Probabilistic Safety Assessment and Management, Waikiki, Hawaii, USA.
- Paper 4:* Optimizing of program for training employees in using safety management systems in the petroleum industry (in review).

8 Appendix

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Interview Guide

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- Paper 4:* Optimizing of program for training employees in using safety management systems in the petroleum industry (in review).

List of informants

Informant nr	Gender	Age	Company	Yrs in comp	Tot yrs offshore	Position	Detail	Employment
1	Male	45-49	A		5	9 Onshore executive	Installation manager onshore	Permanent employee
2	Female	45-49	A		7	0 Onshore executive	Safety executive	Permanent employee
3	Male	60-64	A		0	0 Onshore executive	Developer	Consultant
4	Male	45-49	A		6	28 Offshore executive	Offshore installation manager	Permanent employee
5	Male	40-44	A		5	15 Offshore executive	Marine leader	Permanent employee
6	Male	45-49	A		5	10 Offshore executive	Operations and maintenance manager	Permanent employee
7	Male	50-54	A		4	8 Offshore executive	Operations support team leader	Contractor
8	Female	45-49	A		4	14 Offshore executive	HMS Team leader	Permanent employee
9	Male	60-64	A		3	31 Field Operator	Electrician	Contractor
10	Male	45-49	A		5	5 Field Operator	Electrician	Contractor
11	Male	25-29	A		3	6 Field Operator	Automation	Contractor
12	Male	40-44	A		3	11 Field Operator	Automation	Contractor
13	Male	40-44	A		3	8 Field Operator	Mechanic	Contractor
14	Male	45-49	A		3	7 Field Operator	Mechanic	Contractor
15	Male	50-54	A		3	11 Field Operator	Crane operator	Contractor
16	Female	40-44	A		3	3 Field Operator	Material and logistics	Contractor
17	Male	50-54	A		3	24 Field Operator	Laboratory technician	Contractor
18	Male	35-39	A		3	17 Field Operator	Management technician	Contractor
19	Male	45-49	B		20	18 Offshore executive	Operations and maintenance manager	Permanent employee
20	Male	55-59	B		16	8 Offshore executive	Operation Support Team Leader	Permanent employee
21	Male	40-44	B		14	10 Offshore executive	Operation Support Team Leader	Permanent employee
22	Male	50-54	B		16	0 Onshore executive	Testings group leader	Permanent employee
23	Male	35-39	B		8	6 Offshore executive	Operation Support Team Leader	Permanent employee
24	Male	55-59	B		12	6 Offshore executive	Foreman mechanical	Permanent employee
25	Male	30-34	B		7	3 Offshore executive	Operation Support Team Leader	Permanent employee
26	Male	45-49	B		9	4 Field Operator	Material and logistics	Permanent employee
27	Male	25-29	B		5	4 Offshore executive	Operation Support Team Leader	Permanent employee

Tables 1-7

Table 1: Informants by position in company

Table 2: Informants by age

Table 3: Informants by offshore experience

Table 4: Coding table from step 2

Table 5: Coding table from step 3

Table 6: Main themes

Table 7: Main themes and sub-themes

Table 1

Informants by position in company

	Company A	Company B
Onshore	3	1
Offshore	5	7
Field operators	10	1
Total	18	9

Table 2*Informants by age*

Age	Company A	Company B	Total
25-29	1	1	2
30-34	0	1	2
35-39	1	1	2
40-44	4	1	5
45-49	7	2	9
50-54	3	1	4
55-59	0	2	2
60-64	2	0	2
Total	18	9	27

Table 3*Informants by offshore experience*

Years offshore	Company A	Company B	Total
0	2	1	3
1-9	7	6	13
10-19	6	2	8
20-29	2	0	2
30-39	1	0	1
Total	18	9	27

Table 4
Coding table from step 2

Topic	Sources	References
Describe the management system	25	34
Describe a specific procedure	18	21
Do you use many procedures	2	2
User friendliness	17	21
Optimism	12	23
Do you talk about the management system with you colleagues	19	26
Discussions about the management system	6	7
Detailed procedures	5	8
Own solutions	5	10
Ownership to the system	1	2
Find your own position in the system	11	13
How do you find the procedures you need	21	38
Roundabout in the system	4	6
What works well with the management system	13	15
What does not work well with the system	21	25
What is the main function of the management system	22	29
Does the management system fulfill it's purpose	9	9
Are the described procedures recognizable according to your daily work	22	28
Reviewing the procedures	4	6
What do you find easy with using the management system	1	1
What is being done to ensure that everyone uses the management system	1	2
What could have been done differently	12	16
Who is supposed to use the management system on a daily basis	14	16
What requirements or demands do you relate to when doing a job	21	23
Where is the management system available	7	9
How often do you use the management system	22	26
How often are you supposed to use the management system	9	9
When do you use the management system	21	41
How was the management system introduced	5	6
How should the management system be used	1	1
Reasons for not using the management system	6	13
Communications between different levels in the company	4	4
Training	27	56
How were you introduced to the management system	9	9
How is use of the management system facilitated for	1	1
Repetition of training	3	3
Do you enjoy using the management system	6	6
Deficiencies with the management system	11	12
Participation in development	1	1

Numbering	1	1
Usefulness of the management system	10	12
Development in safety	3	5
Safety	3	5
Do you need a management system	14	16
Organizational challenges in using the management system	5	5
demands resources at an executive level	5	5
To register observations	23	29
notifications on updates on procedures	13	15
What happened when you registered an observation	6	6
Do updates happen often	11	16
Rolled out	3	3
Routine	3	4
They can improve their own use	5	9
Language	7	17
Consequences for not using the system	6	7
Development in technology	1	1
Do you think everyone uses the management system	3	4
Challenges	10	13
Different praxis on different installations	3	5
Development of the management system	2	6
Unwanted incidents	1	1
Regular work day	27	31
Ways of contact	13	14
Face to face contact	5	5
What means of contact do you prefer	8	9
Who are you in contact with on a regular day	20	22
Important for the management in the company	17	20
Cover their back	1	1
Routine job with variations	1	1
Important for the operators	4	11

Table 5*Coding table from step 3*

Vague descriptions of the management system
- What they think the system is
- What is the purpose of the system
- When do they use it
- A tool
User friendliness
Informal procedures
-Their own solutions:
- Print outs
- Unofficial web page
Purpose
- Self interest
- Safety: Vague
Main function
- safety: vague
- for managers to cover their back
- to comply with official regulations
- important to the managers
Safety
- their own competence
- their own experience
- know how to do our job
- guidelines
Training
- web course
- learning by doing
- no repetition
- fiddle about with it
Language
- English and Norwegian
- academic language
- difficult
- different language codes

What is good about the management system
- everything is there
- you get used to it
- the procedures are good
- got to have one
- safety (vague notions)
What is not so good about the management system
- too much information
- difficult to find the right procedures
- why should we use it
Navigating
- finding the procedures
- roundabout
- jungle of procedures
- overload of procedures
- information overload
Use of computers
- Don't like computers
- prefer to do the job
- adds to the word load
- why should we use computers
Register observations
- don't know what it is
- haven't done it
- have done it:
- Got feedback
- Nothing happened
Routine job
Purpose
- safety
- don't need it if they are good at their job
Detailed procedures
Random numbering

Safety
- development in safety
- long term
Discussion about the management system
- In meetings
- at breaks; rarely.
- during work; sometimes. Usually negative.

Table 6*Main themes*

Vague descriptions of the management system
Communication
User friendliness
Dislike computers
Training
Organisational context
Information overload
Language
Informal procedures
Ideals of professionalism

Table 7: Main themes and sub-themes

Main themes	Sub-themes
Vague descriptions of the management system	What they think the system is
	When do they use it
	What is the purpose of the system
	Safety
Communication	Two way communication
	Feedback
	Use of computers
	Interpretation of information
	Language
	Information overload
	Experience
Management system as a tool	
User friendliness	Difficult to navigate
	Information overload
	Language
	Dislike computers
	Creating their own solutions
	Finding work permits
	Access to procedures
Dislike computers	Adds to the work load
	Not seen as real work
	Prefer to just go out and do the job
	Executives expect the workers to be familiar with computers
Training	Web course
	No repetition
	Learning by doing
	Buddy system
	Wants practical exercises
	Skill decay
Organizational context	Use of technology/computers
	Language differences
	Interpretation of information
	Different experience
	Different work environment
	Collaborative community
Information overload	Many procedures
	A jungle of procedures
	Difficult to navigate
Language	Difficult words
	English
	Academic English
	A way for the management to show off
Informal procedures	More practical to use
	Print out a pile of checklists
	Create their own web page
Ideals of professionalism	Using their own judgement instead of procedures
	Do not need the management system if you know how to do your job
	Management system as paper work
	Management system as a means to keep the idiot safe

Intervjuguide – Norsk (Interview guide – Norwegian)

Spørsmål i kursiv er kun for ledere/mellomledere.

Bakgrunn

Alder

Utdanning

Yrkesbakgrunn (andre selskap de har jobbet i, hvilken stilling, andre stillinger de har hatt i SELSKAPET)

Stilling i SELSKAPET (fast, kontraktør offshore)

Antall år i SELSKAPET

Beskriv en typisk arbeidsdag

Evt: - Beskriv arbeidsdagen i går.

- Var den typisk?

- *Hvem er du leder for?*

(Oppfølging: Hvem er du i kontakt med på en vanlig arbeidsdag? Hvordan?

(Ansikt til ansikt, telefon, videokonferanse, chat, annet. Hva synes du er best?)

(*Ansikt-til ansikt-kommunikasjon; er det lagt til rette for det?*)

- Kan du beskrive management-systemet?

- Hvilken funksjon har det?

(Hva mener de det skal brukes til, fyller det den funksjonen det burde ha?)

- Hvorfor har dere det?

- *Hvem mener du skal bruke management-systemet i det daglige arbeidet?*

- *Hvem tror du bruker management-systemet?*

- Hvordan ble management-systemet innført?

- *Hva gjorde organisasjonen for å innføre det?*

- Hvordan ble du introdusert for management-systemet?

Når du gjør en gitt oppgave, hvilke krav forholder du deg til?

- Hvilke prosedyrer?

- Kan du beskrive en arbeidsprosess som du benytter deg av?

- Du spesifikt: Bruker du det/bruker ikke?

- Hvilke arbeidsprosesser bruker du? (evt. Hvorfor ikke)

- Gjenkjenner du arbeidsprosessene i din egen hverdag?

- Hvordan?

- Når? (rutineoppgaver, less frequent activities, sikkerhetskritiske oppgaver)

- Hvis du ikke bruker management-systemet, hva bruker du da i stedet?

- Hvorfor er det bedre?

Hvordan er det å bruke management-systemet?

- Hvor er management-systemet tilgjengelig? (Hvor må de gå for å finne PC, er det tungvint.).
- Hva synes du om brukervennligheten? Hvor lett eller hvor vanskelig er det å bruke det? (få eksempler hele tiden. Hva er det som er så vanskelig).
- Hva er utfordringene med å bruke systemet? (eksempel)
- Finner du fram til de prosessene du trenger? Tar det lang tid, går det raskt?
- Hvor finner du informasjon om systemet?

- *Er det noe straff eller belønning for å bruke management-systemet?*
- Hvor diskuterer dere management-systemet? (i lunsjen, mens de jobber, på møter, med hvem?)
- Kan du gi tilbakemelding om ting som bør endres?
- Hvordan?
- Til hvem?
- Har du gjort det? (hvorfor ikke)
- Hva skjer da?

Hvor har du lært om management-systemet?

- Kurs?
- Hva synes om opplæringen? (kurs/ intern opplæring)
- Hvordan går det å lære opp andre? (hvis aktuelt)
- Er det andre måter de lærer om management-systemet på? (f.eks. gjennom praksis, lærer av andre på jobben)

Hvor ofte er du inne i management-systemet

- Hvor ofte er det ment å skulle brukes?
- Hvordan får du vite om endringer i arbeidsprosessene?
- Får du beskjed når det har vært en oppdatering på en arbeidsprosess de har brukt?
- Skjer endringer i prosessene ofte? Eller sjeldent? En gang i halvåret?

Hva fungerer godt med arbeidsprosessene?

- Hva fungerer ikke?
- Hvilken nytte har det?
- Hvilke mangler?
- Hva ville du ha gjort for å gjøre det bedre?
- Synes du at man trenger et sånt management-system?
- Liker du å bruke management systemet? (hvorfor/hvorfor ikke)

- Hvilke organisasjonsmessige utfordringer er det med å bruke systemet?

- *(F. eks at det er flere firma involvert, Kontraktører)*
 - *Ha kommunikasjonen mellom ulike nivåer i organisasjonen vært bra?*
 - *Er det nok ledelsesressurs i forhold til hva et sånt program krever av ledelse?*
 - *Hvilket fokus er det på det? Hva vil det si?*
 - *Synes du organisasjonen har lagt til rette for at management-systemet skal fungere etter hensikten?*
- Hvis de sier kontinuerlig utvikling: Hva innebærer det? Hvordan har de lagt til rette for at det skal skje?*
- *Hvor viktig er management-systemet for ledelsen?*

Interview guide – English translation

Questions in italics: Only for executives.

Personal information

Age

Education

Professional career (other companies they have worked in, other positions they have had in this company)

Current position in this company (executive, operator, permanent employee, contractor)

Number of years in this company

Describe a typical day at work

Or: - Describe how yesterday was at work

- Was it a typical day?

Executives – Who are under your leadership?

(Follow up: Who are you in contact with on a regular day? How?)

(Face to face. Telephone. Video Conference. Chat. Other. What do you prefer?

(Face to face communication: Is it facilitated for?)

- Can you describe the management system?

- What function does it serve?

(How, in your opinion, should it be used? Does it serve the functions it is supposed to have?

- Why do you have a management system?

Executives:

- Who is supposed to use the management system during the daily work?

- Who do you think uses the management system most often?

- How was the management system implemented?

Executives: What did the company do to implement the management system?

- How were you introduced to the management system?

When performing a task, what kind of requirements and demands do you relate to?

- Which procedures?
- Can you describe a specific work procedure that you use?
- Do you use them? [the work procedures]
 - Which work procedures do you use? (or; why don't you use them?)
 - Are the description in the procedures recognizable relative to your daily work?
 - In what way?
 - When do you use them? (Routine tasks, less frequent activities, safety critical tasks).
- If you're not using the management system, what do you use instead?
- Why is that better?

What is it like to use the management system?

- Where is the management system available? (Where must they go to find a computer, are there practical problems)
- How do you find the user friendliness? Is it easy or difficult to use (ask for examples. If it's difficult: Why)
- What are the main challenges with using the system? (ask for examples)
- Do you find the procedures you need? Does it take a long time? Short time?
- Where do you find information about the management system?

- *Is there any reward or punishment for using or not using the management system?*
- Do you discuss the management system with your colleagues? (during lunch, breaks, during work, in meeting, with whom?)
- Can you give feedback on things you think should be changed?
- How?
- To who?
- Have you done this? (why not)
- What happened then?

How did you learn about the management system?

- Course?
- What do you think about the training? (Courses, in-house training)
- Have you trained others in using the management system?
- What other ways do you learn about the management system? (learning by doing, learn from colleagues etc.).

How often do you use the management system?

- How often are you supposed to use it?
- How are you informed about changes in the procedures?
- Do you get notifications if there have been an update in a procedure you've recently used?
- Are there often changes in the procedures? Rarely?

What works well with the procedures?

- What does not work?
- What the use of the management system?
- What is it lacking?
- What would you've done to improve the management system?
- Is a management system necessary?
- Do you like using the management system? (Why/ why not?)

- What kind of organizational challenges are there with using the management system?

- *(ex are there several companies involved, contractors)*
- *Have the communication between different levels in the company been good?*
- *Is there sufficient management resources with regards to what a program like that requires?*
- *What have been the managerial focus? What does that imply?*
- *In your mind, have the organization facilitated for the management system to function as intended?*
- *If they say «continuous development»: What does that imply? What is being done for this development to find place?*
- *How important is the management system for the leadership in the company?*

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SAFETY MANAGEMENT SYSTEMS - DEFINITIONS, CHALLENGES FOR USE AND RECOMMENDATIONS FOR IMPROVEMENTS.

THOMAS WOLD

Department of Psychology, Norwegian University of Science and Technology, NTNU, NO-7491 Trondheim, Norway. E-mail: Thomas.wold@svt.ntnu.no Office phone: +47 73 59 82 86, Mobile Phone: +47 99 50 62 89 (Corresponding Author)

KARIN LAUMANN

Department of Psychology, Norwegian University of Science and Technology, NTNU, NO-7491 Trondheim, Norway. E-mail: karin.laumann@svt.ntnu.no, Office phone: +47 73 59 09 93

ABSTRACT

In high-risk organizations much effort has been made to standardize procedures in order to streamline human action, to decrease risk and increase productivity. The purpose of using IT-based Safety Management System is to code and share best practices, create corporate knowledge directories and to create knowledge networks for organizations. In the risk and safety literature, these management systems are given various names and definitions. The aim for this paper is to give a review of relevant safety literature and come to a unifying definition of what an IT-based Safety Management System is, describe the purpose of such systems and challenges with using Safety Management Systems.

In the various definitions used in the research literature, we find certain common features: computer based superstructures, or umbrellas, containing procedures, descriptions and checklists on how different tasks should be performed, and what kind of safety standards different tasks require. Usually these procedures are disseminated throughout the organization via an internal computer network, an intranet, where (hopefully) all employees can access the necessary documents.

A central argument in this paper is that the concept of interpretation has been neglected in the safety literature, and that Safety Management Systems should be analysed as a part of an organisations communication. The Safety Management System is constructed at an executive level in the organization and distributed to the lower levels, and at the lower levels, it must be interpreted by the users. There is no guarantee that it will be interpreted as intended. In the development and implementation phases Safety Management Systems in professional organizations the emphasis has often been mainly on the technical requirements, but more attention should be given to the social and cultural facets of knowledge management

Keywords: Safety Management System, communication, procedures, interpretation, culture.

SAFETY MANAGEMENT SYSTEMS REVIEW

In the energy industry, and in other industries operating in a hazardous environment, there has been a development towards controlling the daily workflow through various forms of management systems. Within the various industrial organizations the management systems contains different things. In some organizations they mainly contain procedures for operations at the sharp end, whilst in other organizations the management system also contains procedures on blunt end operations, such as administrating over-time, hiring new staff and ordering new equipment. Also the research literature stems from various academic disciplines, with organizational science and safety science as the two most predominant ones.

In both the the academic literature and in the industry these systems are given different terms, with Safety Management System, Information System and Knowledge System as the most common ones, although someone also uses the terms Knowledge Management System and Information Management System, or even Managing Information System. These terms are somewhat overlapping, but also different. There is no clear consensus within the research literature as to exactly what the different terms means. Hence, two different researchers might use the term Safety Management System in a slightly different manner. The papers reviewed usually don't go deep into discussions about definitions. The approach is more pragmatic, with focus on advantages and disadvantages with using management systems, and on why the workers so often aren't using the management system the way it was intended. Papers within the organizational research often focus on the communication aspects, while the papers within the safety research focuses more on the purpose of the management system, which is to reduce the number accidents and unwanted incidents in industries where the effects of accidents can be catastrophically, like air traffic control, nuclear power plants and gas and petroleum production.

The aim for this paper is to through a review of relevant safety literature come to a unifying definition of what an IT-based Safety Management System is, describe the purpose of such systems and challenges with using Safety Management Systems. A central argument in this paper is that the concept of interpretation has been neglected in the safety literature, and that Safety Management Systems should be analysed as a part of an organisations mediated internal communication.

DEFINITIONS OF MANAGEMENT SYSTEM

In the various definitions used in the research literature, we find certain common features, whether they are labelled Management System, Information System or Knowledge System. They are all IT-based superstructures, or umbrellas, containing procedures, descriptions and checklists on how different tasks should be performed, and what kind of safety standards different tasks require. Usually these procedures are disseminated throughout the organization via an internal computer network, an intranet, where (hopefully) all employees can access the necessary documents.

Knowledge Management System

This term is mostly used within organizational theory. Knowledge management refers to identifying and gathering the collective knowledge in an organization, and hence, a Knowledge Management System is by Alavi and Leidner defined as a "class of information system applied to managing organizational knowledge" (2001, 114). They further explain that knowledge management systems are IT-based, and are developed to support the organization in creating, storing and retrieving knowledge. Building on Davenport and Prusak (1998), they state that knowledge management is about making knowledge visible, to develop a knowledge-intensive culture and to build a knowledge infrastructure, which they state is not only a technological system, but a web of connections where people are given the space and the time to interact and collaborate (Alavi and Leidner 2001). The notion that these systems are not merely technological systems, but socio-technical systems, is shared by many researchers. A related term from safety science is Active Knowledge Support in Integrated Operations (Norheim and Fjellheim 2007), defined as "a socio-technical system for knowledge transfer between drilling projects, trough documented experiences, best practices, and expert references" (ibid, 2). This definition is linked to petroleum industry, but is applicable to other industries as well, as it is point out at the general idea is to provide decision makers with the best available knowledge, and to facilitate for feedback to capture new knowledge and to delete obsolete knowledge.

Information System

In the research literature there doesn't seem to be a general agreement what an Information System is, but in the organizational literature it is often given similar definitions as Knowledge Management System. One definition is "an open system capturing, contribute to the cognitive tasks in a social/organizational setting" (Avgerou 1987, 135). This is a rather broad definition, and Avgerou goes further to discuss how an information system is embedded in a social and organizational environment, hence establishing the idea that an information

system involves more than just building a complicated software system (Avgerou 1987). One might define Information Systems by its purpose, which is to “support and augment organizational knowledge and enhance knowledge management activities by the individual and the collective” (Alavi and Leidner 2001, 115). They too point out that although this is computer mediated communication, an Information System must be rooted in and guided by an understanding of the nature and types of organizational knowledge in order to succeed. Information system has also been described as social systems which rely on information technology for their function, and in where technology is never more than a component (Land and Hirschheim 1983, cited in Avgerou 1987). In other words, an information system is not merely a computer system, and can be linked to the previous mentioned notion from the safety literature of a knowledge management system as a “socio-technical system for knowledge transfer” (Norheim and Fjellheim 2007).

Safety Management System

An often cited definition within the safety literature is that safety management relates to the actual practices, roles and functions associated with remaining safe (Kirwan 1998). A similar definition of safety management is that it is “the policies, strategies, procedures and activities implemented or followed by the management of an organization targeting safety of their employees” (Vinodkumar and Bhasi 2011). Safety Management System is hence a formalized way of dealing with these practices, roles, policies and procedures. Safety Management System is defined in various ways in the safety literature. Some definitions are rather formally descriptive, for instance “an organisation’s formal arrangement, through the provision of policies, resources and processes, to ensure the safety of its work activity” (El Koursi, Mitra and Bearfield 2007, 4), or, more generally, as “a manifestation of the organization’s safety culture” (Fernández-Muñiz, Montes-Peón and Vázquez-Ordás 2007).

A Portuguese study within the organizational research a slightly different term is used, but the definition is similar: A Occupational Health and Safety Management System is here defined as “a set of tools that enhance safety risk management efficiency related to all the organization’s work activities” (Santos, Barros, Mendes and Lopes 2013, 29). They describe it as a self-regulatory regime and as a tool to promote and develop health and safety conditions, in which the purpose is to ensure that all work performed in the organization is in accordance with legal obligations. Another definition from the safety literature points to the place of the Safety Management System in the organization; as an integrated mechanism of the organization, and to the purpose of the system; to control the hazards that can affect workers’ health and safety (Vinodkumar and Bhasi 2011). A similar definition stems from the United Kingdom Civil Aviation Authority (UKCAA). They define Safety Management Systems as a “methodology by which a company manages safety throughout its organization, utilizing a systematic approach to ensure that all parts of its business are addressed and that all risks are identified and subsequently managed” (UKCAA 2002, as quoted in Chen and Chen 2012). The International Labour Office defines Safety Management Systems as “a set of interrelated or interacting elements to establish safety policy and objectives, and to achieve those objectives” (ILU 2001, as quoted in Bottani, Monica and Vignali 2009, 155). To sum up these various definitions we can gather that Safety Management Systems are IT-based superstructures containing procedures, descriptions and checklists on how different tasks should be performed according to official regulations, safety standards and corporate values. They are socio-technical systems of which the purpose is to support the organization in creating, storing and retrieving knowledge.

THE PURPOSE OF A SAFETY MANAGEMENT SYSTEM

It is easier to find a consensus in the literature when it comes to describing the purpose of the various management systems, which is of course to reduce accidents and risk by standardizing the work procedures, though the phrasing differs. Santos-Reyes & Beard label it “The Systematic Safety Management System (SSMS)”, but the purpose of it is similar; to maintain risk within an acceptable range in the operations of any organization (Santos-Reyes and Beard 2009), which is basically the same as to help the organization identify and manage risk effectively (Koursi, Mitra and Bearfield 2007). Several researchers also underline another purpose of Safety Management Systems, which is to help the organization meet the regulatory requirements (Hale, Heming, Catfhey and Kirwan, 1997; Koursi, Mitra and Bearfield 2007; Antonsen, Almklov and Fenstad 2008; Chen and Chen 2012). There is also a general agreement that Safety Management Systems is a means to change safety management from being reactive to being proactive (Liou, Yen and Tzeng 2008), and anticipating hazardous situations before they occur, and not just acting after an accident has occurred, or phrased differently; to protect against human error (Dien 1998; Dekker 2003; Antonsen 2009). There is also the matter of defining legal responsibility if incidents should occur (Antonsen, Almklov and Fenstad 2008). Antonsen (2009) describes how the interest for Safety Management Systems came as a consequence of the increased focus on the organizational conditions for safety in the 1980s. An important assumption was that accidents are mainly caused by human error or failure. Hence, the way to decrease the chance for human error and making the organization operate safer is by

creating management systems that specifies objectives, distributes responsibility, plans, organize and controls according to safety precautions (Antonsen 2009, 9). This is not only a matter of coordinating between tasks, but also the accumulation and diffusion of organizational experience, and to turn tacit knowledge into explicit and shared knowledge (Haavik 2010).

In any organization there will always be tacit knowledge, and much effort is made in order to turn tacit knowledge into explicit and shared knowledge, and to make invisible work processes visible and transparent. If those who actually perform the work are the only ones who knows how it is done, the ability to account for this invisible work and the tacit knowledge that accompanies it, can strengthen the organization's performance significantly (Haavik 2010). However, tacit knowledge can be so complex that it is difficult to articulate in a way that makes sense, and many professions demand a certain experience in order to be able to make complex considerations (Sohlberg 2009). This is not to say that tacit knowledge needs to remain tacit. Tacit knowledge is "the personal knowledge that is learned through extended periods of experiencing and doing a task, during which the individual develops a feel for and a capacity to make intuitive judgments about the successful execution of the activity" (Choo 2001). This type of knowledge can also be made explicit and brought forward to other workers who lack the experience, which the management system is an attempt to systematize. This way the separating lines between tacit and explicit knowledge will be moved, so that knowledge that was tacit yesterday is explicit today (Sohlberg 2009). So, the purpose is to increase safety by decreasing the chance for human error and by making sure that regulatory requirements are met at all times, but also to define legal responsibility if incidents occur, and to build a stronger organization by accumulating organizational knowledge.

SAFETY MANAGEMENT SYSTEM AND PROCEDURES

IT-based Safety Management Systems contains a lot of procedures covering various work operations. Procedures are often constructed on the basis of analysing accidents and other unwanted incidents, but also on the already established routines, and on legal demands set by the authorities. Procedures delivers formalized methods for carrying out tasks, such as checklist, task list, action steps, instruction manual, fault- finding heuristic, forms to be completed (Bellamy et al 2010). Procedures are usually seen as protective mechanism against human error, but can also be seen resources to facilitate situational decision making.

In the research literature much focus has been on managing maintenance activities in hazardous environments, where routine tasks need to be performed under changing circumstances. Humans make mistakes, so rules and procedures are designed to control these human characteristics, and hence improve the reliability of humans and organizations, particularly in safety-critical organizations (Reiman 2011). Thus, procedures might become rather restrictive. However, several researchers have pointed out that people do not always follow procedures (Lawton 1998; Dekker 2003; McDonald 2006; Antonsen 2009; Reiman 2011). Dekker (2003) gives an account for two different models of thinking about procedures. The first model is where procedures are seen of as the best thought-out and safest way to carry out a job. According to this model, safety comes from people following procedures in as a simple rule-based activity. In the second model, procedures are seen as resources for action. The do not specify all circumstances to which they apply, and in dynamic workplaces procedures can help people to structure activities across similar but subtly different situations (Schuman, 1987, as referred to in Dekker, 2003). Doing this successfully can be a "substantive and skilful cognitive activity" and safety is a result of "people being skilful at judging when (and when not) and how to adapt procedures to local circumstances" (Dekker, 2003, p. 235). The challenges with using IT-based Safety Management Systems are quite similar to the challenges of using procedures, and includes time pressure, lack of flexibility, a sense that there are better and quicker ways to get the job done, but is also linked to the workers image of themselves as professionals. A lack of flexibility and information overload can also lead to situations where the workers are not able to interpret the procedures and adjust them to the situation at hand.

CHALLENGES WITH USING SAFETY MANAGEMENT SYSTEMS

Several researchers argue that management systems have helped to reduce accident rates by the principle of prevention (Santos et al 2013), while others stress that the literature in this area is lacking, and that there is little research evidence that safety management practices are related to safety performance (Vinodkumara and Bhasi 2010). Any Safety Management System in itself says little about how policies and procedures are carried out in the field (Mearns, Whitaker and Flin 2003), and Safety Management Systems do not always improve the results of safety because they are centred exclusively on the technical requirements and on obtaining short-term results (Weinstein 1996). Clearly, any organization needs to share experiences and best practices, and to administrate this in an effective way, but to get the acceptance from management and staff to use the tools in practice demands a lot of energy from managers and staff who will have to change their working patterns and habits, without losing

tempo on the daily operations. Safety Management Systems are based on the assumption that people will follow the procedures most of the time, but why do workers so often avoid using the Safety Management System?

The worker's ideals of professionalism

In a study of UK railway workers motives for rule violations, Lawton found that a well-intentioned desire to get the job done often resulted in deliberate deviations from the written rules. The most important reasons for non-compliant behaviour was a quicker way of getting the job done, but also self-imposed or external pressure to get the job done more efficiently (Lawton 1998). This may also have symbolic value for the workers' image of themselves as professionals. Not only deadlines, but also peer pressure and professional expectations can make violations become compliant behaviour. When unofficial action yields better, quicker ways to do the job, it also functions as a sign of competence and expertise. Being able to outsmart hierarchical control and compensate for higher-level organizational deficiencies or ignorance becomes a part of one's professionalism (Dekker 2003; Hollnagel 2004; 2009; Reiman 2011). McDonald (2006) notes how the technicians doing aircraft maintenance justified their violation from procedures by reporting there were 'better, quicker, even safer ways of doing the task than following the manual to the letter' (McDonald 2006, 161). The technicians often see this as a part of their professionalism, and as something that compensates for organizational dysfunction. Rules and procedures can be a source of tension for the personnel, afraid of losing their professional identities as skilled craftsmen and becoming "a small cog in a big machine" (Reiman and Oedewald 2006). They often value the use of one's own judgement and being confident in one's own abilities to solve problems, and not just following rules (McDonald 2006). This can be seen as a version of the tradition of valuing common sense over paperwork. Borys (2009) found that paperwork became a ritual for the workers, something they did to abide to the company's rhetoric about safety, but thought that their own common sense was more significant in order to keep them safe. Managers, on the other hand, valued the paperwork related to risk-awareness because it gave them evidence that workers have thought about risk (Borys 2009).

It would be profitable to establish a link between using formal work description and the ideals of professionalism. A Norwegian study showed how a group of aircraft line maintenance technicians valued procedures, rules and regulations as guides for work practice, but at the same time, they distrusted them, and sought to adapt their practises depending on the situation (Pettersen and Aase 2008). Applying procedures successfully across situations demands skill, and can be integrated in the ideals of professionalism. Being skilful at judging when and how to adapt procedures to a given situation or circumstances is what safety results from (Dekker 2003). Adaption and interpretation of rules is often considered part of the work (Reiman 2010), not only as a part of the worker's sense of professionalism, but also it is quite necessary because of the sheer volume of rules and procedures they need to navigate through, and because procedures cannot apply to just about any situation that might occur.

Information and procedure overload

There is a general agreement in the research literature that rules and procedures are useful guides for safe behaviour, but there is also a concern that it might be counterproductive to have too many rules and too detailed procedures. A jungle of procedures does not allow the operators to develop an underlying plan of their own but rather lead them into focusing only on micro-difficulties (Grote et al 2009). If the operators get too caught up in the tiniest of details, they might lose grasp of the bigger picture of what is going on. It is impossible to have procedures to anticipate all the situations and conditions that might occur, so there will always be situations where best practice relies on the judgment of the operator (Sutcliffe 2011). A related problem is that over time an organization will create a large number of rules and procedures, so that the sheer amount can make it difficult to choose which rules and procedures to activate for a specific scenario. For instance, after accidents or unwanted incidents, it can be tempting to introduce new procedures or change existing ones, as a highly visible reply to demands from regulatory authorities that some kind of action be taken (Dekker 2003; Antonsen, Almklov and Fenstad 2008). The desire to make the procedure as realistic as possible, and to have procedures to match any situation, contributes to an increasing number of procedures to the point where it becomes a jungle, creating difficulties in deciding which procedures to apply (Alavi and Leidner 2001; Antonsen, Almklov and Fenstad 2008). Similar to an information overload scenario, a procedure overload can discourage workers from searching through the jungle of knowledge (Alavi and Leidner 2001), and an ever expanding Safety Management System will make navigating difficult.

Lack of flexibility

Safety Management Systems and procedures contains a lot of “do not”. They are often designed with the intent to prohibit actions that may create hazardous situations, and as a result have a tendency to become increasingly restrictive (Antonsen 2009). Extensive rules and procedures might be at the expense of flexibility, so it is important to balance the need for standardization and the need for flexibility (MacDonald 2006; Grote et al 2009; Sutcliffe 2011). In a context of limited resources, multiple goals, and time pressure it can sometimes be impossible to follow all the rules and get the job done at the same time (Dekker 2003). Some studies also indicate that the workers will more often violate procedures that are seen as overly detailed restrictions (Antonsen, Almklov and Fenstad 2008). Standardization can also lead to an over-reliance, meaning that the workers trust the standardized procedures blindly and never question whether this really is the best way of doing the job (Grote et al 2009). The question of just about how detailed procedures need to be can probably never be given one general answer. It depends on the nature of the tasks involved, among other things. Tasks that are performed rarely, or are quite complex or require coordination between several units in the organisation, will usually need more detailed descriptions than routine tasks that the workers are quite familiar with, which can be governed by more general functional requirements (Antonsen, Almklov and Fenstad 2008). Strongly regulated organisations are likely to benefit from it safety-wise if they manage to create some space for individual decision making. Reiman refers to Bourrier’s (1996) demonstration of how ever expanding procedures did not support individual decision making on behalf of the workers, and that local adjustments of rules and regulations is necessary for organizations to effectively pursue their goals (Reiman 2010). If workers only follow rules, and are not able to decide when the procedures should be adapted according to a specific context, they can get blamed for their inflexibility (Dekker 2003). Safety Management Systems and procedures are resources for action, but cannot dictate their own application or guarantee safety. They are not ever likely to be sufficient for creating safety, but need to be adapted by people with sensitivity to context. The clue then is not simply telling people to comply, but to help them develop skills to know when and how to adapt (Dekker 2003).

DISCUSSION

What the various definitions have in common, is that they describe the Information System, Knowledge System or Safety Management System of a company as a IT-tool that contains descriptions and procedures on how certain task should be performed, checklists, safety regulations, and to secure that these are available for all units in an geographically dispersed organization. It is usually regarded as a sub-system of the total organizational management, and the purpose is to control the hazards that can affect workers’ health and safety, to avoid incidents that may harm the environment or the company’s economy, and to enable the organization as a whole to learn from experiences. Of all the various terms used, Safety Management System seems to be the most common one, and is also the term that best connotes what it is actually meant to be. Safety Management Systems are socio-technical systems containing procedures, descriptions and checklists on how different tasks should be performed according to official regulations, safety standards and corporate values, and supports the organization in creating, storing and retrieving knowledge. In some organizations they mainly contain procedures for operations at the sharp end, whilst in other organizations the management system also contains procedures on blunt end operations, such as administrating over-time, hiring new staff and ordering new equipment. Also the research literature stems from various academic disciplines, with organizational science and safety science as the two most predominant ones.

Safety Management Systems are living systems and are never completely finalized in their making, but should always be open for evaluation, adjustment and changes. Ideally they should always be developed on the basis of new experience, in order to replicate success. Three ingredients are particularly important for a successful match between procedures and practice: There should be feedback from the lower to the upper tiers of the organization, the adjustment of procedures should be based on the views of those directly involved, and the time interval between worker feedback and implementing changes should be as short as possible. In existing system one must study the interaction between human and system to find to identify various problems and deficiencies.

Safety Management Systems in professional organizations have in several cases been unsuccessful because in the the development and implementation phases the emphasis has often been mainly on the technical requirements, while more attention should be given to the social and cultural facets of knowledge management (Cox and Cheyne 2000; Alavi and Leidner 2001; Rai, Maruping and Venkatesh 2009; Vinodkumar and Bhasi, 2011). For instance, Antonsen (2009) showed how seamen saw practical sailing experience as the backbone of safety. They were frustrated by being forced to work by formal procedures and checklists, and interpreted it as a sign of distrust from the management who did not appreciate their professional expertise (Antonsen 2009). Similar findings emerged from a study of two maintenance organizations in Australia, where managers focused upon collecting paperwork associated with the safety program, unaware that the front line workers valued their own

“common sense” over formal rules, making the paperwork a ritual they performed only to appease a rhetoric about safety (Borys 2009). In a study of a petroleum producing company using an IT-based Safety Management System, it became clear that several of the electricians and mechanic working on the offshore installation, simply did not like computers and would rather avoid it; they preferred to simply go out and “do the job” rather than reading documents on a screen first (Wold & Laumann, 2015). One of the challenges with using IT-based Safety Management System is that they typically contain a lot of do-not, and hence become very restrictive. A related challenge is that over time an organization might create a large number of rules and procedures, so that the sheer amount can make it difficult to choose which rules and procedures to activate for a specific scenario, and that navigating in the jungle of Safety Management System becomes difficult and time consuming. A jungle of procedure does not allow the workers to develop an underlying plan of their own but rather lead them into focusing only on micro-difficulties. It is impossible to have procedures to anticipate all the situations and conditions that might occur, so there will always be situations where best practice relies on the judgement of the worker. This has relevance for how the workers see themselves as competent professionals. The workers often prefer not to use the Safety Management System because they thought there was a quicker and better way of doing the job, which also functions as a sign of competence and expertise.

Safety Management Systems must be interpreted

In both the organizational literature and the safety literature the matter of interpretation has often been neglected. Though several authors stress the human component, it is usually in the perspective of how to get the human workers to use the technology in a better way. Interpretation of technology is usually not discussed, and although most authors define the management system as “IT-based”, they don’t discuss it as a mediated message that comes to life in the interface between human and technology. The tendency is to regard Safety Management Systems and the procedures as tools. As tools they don’t require any interpretation, just a little bit of training, and then the worker will be more efficient at using the tool the more experienced he or she is. Dekker (2003) points to one aspect of interpretation; Procedures do not specify all circumstances to which they apply. Hence, people at work must interpret procedures with respect to a collection of actions and circumstances. However, this is only one aspect of interpretation.

Any Safety Management System, no matter how it is constructed, is communication. It can be convenient to pretend that this is one-way communication, but it’s not, because the user interprets the information in the Safety Management System and turns it into knowledge, adding his or her prior knowledge and experience. The cognitive strengths of humans must be emphasized, but also how operators interact with management systems and procedures. Not only shall machines be designed to suit the physical abilities of the expected user, but instructions and procedures shall be designed to fit their mental abilities; the cognitive, informational and emotional processes in the human being.

Reiman (2011) argues that research should aim at developing methods and approaches for evaluating the functioning of the maintenance organizations holistically, taking into account the individual, social and organizational elements.

One way of doing this and to stress the importance of interpretation is to analyse the IT-based Safety Management System as a system for communication. Any information that is communicated must be interpreted before it makes any sense to the receiver (Morley 1992; McQuail 1997). While interpreting the information, the receiver turns the information into knowledge, adding his or her prior experience (Wold & Laumann, 2014). The safety literature tends to implicitly use a linear transfer model of communication, where every message is understood as intended, but in reality this is not the case. Information is constructed according to the prevailing values and attitudes of the management in the organisation, and then communicated through various forms of media, in this case an IT-based Safety Management System, although other media is also being utilized, like radio, e-mail, flyers, posters, group meetings and face-to face talks. The individual operator in the organization will interpret the communication and accept, negotiate or reject it (McQuail 1997; Hall 1980, 2002). In the communicative exchange there can be various degrees of understanding or misunderstanding and this will depend on degrees of symmetry or asymmetry established between the positions of the executives and the operators within the organization. In other words: The Safety Management System is constructed at an executive level in the organization and distributed to the lower levels, and at the lower levels, it must be interpreted order to make sense. There is no guarantee that it will be interpreted and understood as intended. Sometimes it is something as banal as that the management uses different words and grammar than the workers are used to, or they understand the same words differently, but it can also be related to more profound background factors, like education, working situation, and their basic understanding of the world in general and the organization in particular.

Cultural distortions in communication

In any culture, also a business culture, there will be some values and ideas about the world that is more or less taken for granted. Certain codes in a specific language community or culture are so widely distributed that they appear as naturally given and not as cultural constructs (Hall 2002, 132). The set of values and forms of expression shared by the people are just as important to the behaviour of the members of an organization as its formal goals, structure and tasks (Bouwman et al 2005). This has a great deal to do with the structural difference in the position between the sender and the receiver of a message, or, as in our case, between staff at different levels in the organization. What are called “distortions” or “misunderstandings” arise precisely from the lack of equivalence between the two sides in the communicative exchange (Hall 2002, 131). The individuals of a professional organization are assigned tasks within a specific hierarchical structure, which usually roughly consists of a top management level, a staff, a middle management level and a work floor. It is plausible to assume that there will be asymmetry between the codes of “source” and “receiver” – in other words, the top level of the organization might not share the same codes as the lower level, or the lower level might understand and interpret these codes differently. Another factor is that the different levels of the organization are not necessarily in perfect harmony with each other. Resentment towards the leadership will influence the interpretation. In some cases they can have similar interests. For instance, a profitable result for the organization is usually in everyone’s interest, but there are also situations where they can have different interests. People with different roles in the organization might have different frames of reference. The individual member of the organisation will interpret any mediated message in light of his or her previous knowledge and experience, and frames of references. Professional organizations have often tried to create a corporate identity to unify the different levels in the hierarchy, and to create an organizational common sense in order to avoid misunderstandings. It will be useful to consider how some frames of references are shared by the entire organizations, and at the same time, how each level of the organization might have specific frames of references which are unknown at the other levels in the organization, and how different subcultures within the organization operate with different frames of references.

Future improvement

For future improvement IT-based Safety Management Systems must focus more on the areas of human factors and the associated developments on health and safety (Cox and Cheyne 2000). Human factors revolves around the central importance of the user, and the goal of human factors is to enhance performance, increase safety and increase user satisfaction. This includes the communication and cognitive processes involved in using the system. If human factors methods and principles are applied as early as possible in the development of a system, in predesign analysis, technical design, and final test and evaluation, many of the human factors deficiencies will be avoided before they are inflicted on systems design (Wickens, Lee, Liu and Becker 2004). The use of software technology cannot be studied isolated from its environment. The organizational context is crucially important. The formal descriptions, procedures and standardizations are artefacts and should be treated as such (Grote et al 2009). However, sometimes it becomes routine not to follow the standardized procedures. New technology in the workplace might be seen as something interesting to learn, and as something that makes the work procedures easier, but can also be seen by the workers as a threat to ones status if tasks are changed or “taken over” by automation, or one might feel that it is difficult and just adds to the work load.

Good procedures and work descriptions are needed in any organization operating in hazardous environments, and these must be organized in a management system where they can be easily located and retrieved for a large number of workers. It is important that the procedures and work descriptions don’t get too detailed or too extensive, as it may lead to that the worker gets too hung up in the tiniest of details and loses the overall understanding for the task and the context. If procedures get too detailed, it will stop the workers from thinking on their own. This thinking is always a resilience factor, as it is impossible to create procedures that can foresee any situation. More research is needed here to investigate exactly how detailed procedures should be. It can be fruitful to differentiate between different types of procedures. It might very well be that procedures for more extreme or accident situations should be more detailed than procedures for more ordinary work situations. Qualitative situation analyses could be a useful research method here.

People at work must interpret procedures with respect to a collection of actions and circumstances that the procedures themselves can never fully specify (Dekker 2003). There will always be situations that require the worker to evaluate different alternatives and make a choice. Reiman (2010) argues that maintenance has too often been considered as mostly manual labour requiring little or no mental work. This is probably why the matter of interpretation has been neglected in safety research. A central subject for further research should be how the workers interpret and understand the procedures and the Safety Management System, on how their interpretation affects how they use the Safety Management System.

Procedures and Safety Management Systems are usually developed by management and experts who are not involved at the operational level. A key challenge here is to involve the workers in the development of the procedures and Safety Management System. These must be constructed so that they increase ownership of work, and not decrease ownership of work. One should utilize the competence and experience of the workers when developing the procedures and the workers should also have the opportunity to give feedback on how useful the procedures and the management system are. The communication that a Safety Management System constitutes is mainly a linear communication from the upper tiers of the organization to the lower. There should be feedback travelling the other direction as well, so that that adjustments or procedures can be based on the views of those directly involved. It is also important that the time interval between worker feedback and implementing changes is as short as possible. A Safety Management System must not be installed instead of training. In-house training is essential in order to get the workers to use the Safety Management System as intended, and for the workers to see why it is important.

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Safety Management Systems as communication in an oil and gas producing company



Thomas Wold*, Karin Laumann

Department of Psychology, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway

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ABSTRACT

An IT-based Safety Management System contains procedures, safety standards and checklists on how different tasks should be performed. Safety standards and work procedures designed at the executive level in the organization are communicated to the lower level in the organization where they are being applied. How is this information perceived and understood at the receiving end? This paper presents a case study of how managers (onshore and offshore) and operators at an offshore installation perceive and use the management system.

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1. Introduction

The purpose of this paper is to investigate how an IT-based Safety Management System is being used in a given context, and to discuss the potential for improvement both in the Safety Management System itself and in the use of it, by analyzing the Safety Management System not merely as a tool, but as a communication system. In this paper the given context is the petroleum producing installation of an oil and gas producing company. In the energy industry, and in other industries operating in a hazardous environment, there has been a development towards controlling the daily workflow through various forms of management systems. An often cited definition of safety management is that it relates to the actual practices, roles and functions associated with remaining safe (Kirwan, 1998). A similar definition of safety management is that it is “the policies, strategies, procedures and activities implemented or followed by the management of an organization targeting safety of their employees” (Vinodkumar and Bhasi, 2010 p. 283). A Safety Management System is hence a formalized way of dealing with these practices, roles, policies and procedures, and is defined in various ways in the safety literature. Some definitions are rather formally descriptive, for instance “an organization’s formal arrangement, through the provision of policies, resources and processes, to ensure the safety of its work activity” (El Koursi et al., 2007 p. 4), or, more generally, as “a manifestation of the organization’s safety culture” (Fernández-Muñiz et al., 2007 p.53). More

specifically, Safety Management Systems can be seen as “a socio-technical system for knowledge transfer [. . .], through documented experiences, best practices, and expert references” (Norheim and Fjellheim, 2007:2). Keeping these documents up to date is important, and although most documents are developed according to a top-down approach, a Safety Management System can also be an instrument for knowledge flow the other way so the practical experience and implicit knowledge of the workers can be incorporated in the living documents (Hale et al., in press; Hale and Borys, 2013; Blakstad et al., 2010; Bragatto et al., 2010). Safety Management Systems are integrated mechanisms in the organizations, and the purpose is to control the hazards that can affect workers’ health and safety (Chen and Chen, 2012; Vinodkumar and Bhasi, 2011), to maintain risk within an acceptable range in the operations of any organization (Santos-Reyes and Beard, 2009; El Koursi et al., 2007), and to help the organization meet the regulatory requirements (Chen and Chen, 2012; Antonsen et al., 2008; El Koursi et al., 2007; Hale et al., 1997). This is not only a matter of coordinating between tasks, but also the accumulation and diffusion of organizational experience, and to turn tacit knowledge into explicit and shared knowledge (Haavik, 2010). There is also a general agreement that Safety Management Systems is a means to change safety management from being reactive to being proactive (Liou et al., 2008), and anticipating hazardous situations before they occur, and not just acting after an accident has occurred, or phrased differently; to protect against human error (Antonsen, 2009; Dekker, 2003; Dien, 1998). There is also the matter of defining legal responsibility if incidents should occur (Antonsen et al., 2008).

* Corresponding author. Tel.: +47 73 59 82 86 (O), mobile: +47 99 50 62 89.
E-mail address: Thomas.wold@svt.ntnu.no (T. Wold).

2. Theoretical background: Safety Management System as communication systems

The matter of interpretation has been neglected in the research literature on procedures and Safety Management Systems. Several authors stress the human component, but merely in the perspective of how to get the human workers to use the technology in a better way. Interpretation of technology is usually ignored, and although several researchers define the Safety Management System as “IT-based”, they do not consider it to be a mediated message that comes to live in the interface between humans and technology. The tendency is to regard Safety Management Systems and the procedures as tools that just need to be put to good use. Dekker (2003) points to one aspect of interpretation; Procedures do not specify all circumstances to which they apply. Hence, people at work must interpret procedures with respect to a collection of actions and circumstances. To further stress the importance of interpretation the IT-based Safety Management System should be analyzed as a communication system, with mediated messages traveling from the top levels of the organizational hierarchy downwards to the lower levels.

The communication between different levels of a professional organization relies on use of different types of media, so reception analysis will be useful to research how and why different interpretations and even misunderstandings occur (McQuail, 1997; Morley, 1992). Reception studies are concerned with the *production* of messages and with the *reception* of those messages by an audience, intended or otherwise (Shore, 1998). Internal communication in a professional organization is about communication to an intended audience, where there is (or at least should be) no doubt what the preferred meaning of the mediated text is. In our ordinary lives it is quite common that we send a message, believing it was clear and unambiguous, but then responses and reactions indicate totally different and unexpected interpretations (Drottz-Sjöberg, 2012). This happens within professional organizations as well. The meaning structure constructed by the receiver of the message is not necessarily the same as the meaning structure intended by the sender (Hall, 2002, 1980; McQuail, 1997). The Safety Management System is mainly constructed at an executive level in the organization and distributed to the lower levels, and at the lower levels, it must be interpreted order to make sense. There is no guarantee that it will be interpreted as intended.

The individuals of the organization are assigned tasks within a specific hierarchical structure, which usually roughly consists of a top management level, a staff, a middle management level and a work floor. The set of values and forms of expression shared by the people are just as important to the behavior of the members of an organization as its formal goals, structure and tasks (Bouwman et al., 2005). What are called “distortions” or “misunderstandings” arise from the lack of equivalence between the two sides in the communicative exchange (Hall, 2002). In a professional organization it is plausible to assume that there will be asymmetry between the codes of “source” and “receiver” – in other words, the top level of the organization might not share the same codes as the lower level, or the lower level might understand and interpret these codes differently. This can be something as banal as that they understand the same words differently, or they use different kinds of words unfamiliar to each other, but it also a matter more profound background factors. For instance, Antonsen (2009) has shown how seamen often interpreted attempts to govern work by formal rules as a negation of the seafarer’s professional expertise. This will no doubt affect their respect for and their motivation for using the formal procedures. In addition, formal procedures have their origin in onshore organizations, like regulatory authorities and oil companies. This is outside the

seafarer community, or the ones doing the practical work, and this influences how the seamen interpret the formal safety management. The seamen in Antonsen’s study saw the procedures as based on the theoretical knowledge of some “office worker”, and not as based on the practical knowledge possessed by competent seamen, and for them this undermines the legitimacy of formal procedures (Antonsen, 2009). This effect might be enhanced or reduced by the way procedures are constructed. Dekker (2003) gives an account for two different models of thinking about procedures. The first model is where procedures are seen of as the best thought-out and safest way to carry out a job. According to this model, safety comes from people following procedures in as a simple rule-based activity. In the second model, procedures are seen as resources for action. The do not specify all circumstances to which they apply, and in dynamic workplaces procedures can help structure activities across similar but subtly different situations (Schuman, 1987, as referred to in Dekker, 2003). Doing this successfully can be a “substantive and skillful cognitive activity” and safety is a result of “people being skillful at judging when (and when not) and how to adapt procedures to local circumstances” (Dekker, 2003, p. 235). In this respect, applying and adapting procedures in good judgement can be incorporated as part of the workers’ professional identity.

This is also a human factors issue, as it relates to the interaction between human and the system. The precise boundaries of the discipline of human factors cannot be tightly defined but are closely related to ergonomics, engineering psychology, and cognitive engineering (Wickens et al., 2004). Human factors have often been concerned with the physical aspects of work, but the scope also includes cognitive thinking and knowledge-related aspects and mental interactions with the system (Andersen, 2013; Stanton et al., 2005; Wickens et al., 2004). Hence, human factors should be applied at an early phase in determining how the Safety Management System and the procedures should be developed to ensure user friendliness, and how the staff training should be.

3. Method

3.1. Subject

The empirical data is collected by conducting qualitative in-depth interviews with 18 staff members of an oil and gas producing company in Norway. Three informants were onshore executives who have had an active role in the development of the company’s Safety Management System. These were interviewed in a preparatory study to gain insight in what their priorities were when developing the Safety Management System, and how they thought it should be put to use on the offshore facility. This material was used to prepare interviews with five offshore executives and 10 offshore workers, representing different disciplines; mechanics, electricians, logistics and lab technician.

3.2. Procedure

The interviews with the offshore executives and workers were conducted on the petroleum producing installation in a separate room during their normal working hour. The interviews followed a semi-structured interview guide, where certain topics were planned in advance, but also allowing for the informant to bring new topics to the table, and also allowing for the structure for each interview to be different according to how the informant associated the various topics. The interview started off by letting the informants tell about their routines for an ordinary work day and to describe the Safety Management System and the purpose of it. The questions then became more detailed about which procedures

they used and in which situations, how they learnt about the Safety Management System, about the user friendliness of the system, shortcomings and advantages. The interviews offshore lasted for 30–45 min. The interviews with the offshore executives lasted longer than the interviews with the workers. The interviews were conducted and transcribed by the first author of this paper.

3.3. Data analysis

The data was analyzed using a thematic analysis. Thematic analysis offers a theoretically-flexible approach to analyze the major themes to be found in interviews (or other qualitative data) (Howitt, 2010; Braun and Clarke, 2006; Aronson, 1994). The first step was familiarizing with the data by transcribing the audio interview tapes. The transcribed material was then fed into the software program NVIVO 10 and coded into many categories and sub-categories (nodes is the term used in NVIVO 10). This first round of coding was rather broad, where each interview segment could be coded in several categories, where relevant surrounding data was kept to keep track of the context. After the initial coding it was evident which categories could be developed into themes and which categories were too small to qualify as themes. The themes were not necessarily the same as the topics in the interview guide, some were of course, but new themes also arrived during the interviews, and some themes emerged when looking at certain keywords mentioned by some of the informants, and by looking at in which context they mentioned these words. After re-reading the coding of each theme, some themes collapsed into each other whilst other themes were broken down into separate themes. The initial codes were partly derived from the interview guides, but several new and sometimes unexpected codes emerged from the interview material. What eventually became themes was mainly guided by the interview material, and not theory driven.

4. Results and discussion

After the coding process was finished, the themes presented in Table 1 had emerged.

4.1. Context

The Safety Management System of the petroleum producing company in this study is an IT-based superstructure, or umbrella, containing procedures, checklists and descriptions of how different

tasks should be performed, and what kind of safety standards different tasks require, disseminated throughout the organization via an internal computer network; an intranet. The system was constructed by an external consulting company, while some of the onshore and offshore executives were involved in the development of the procedures. The executives can access the Safety Management System from their computer in their office. The operators on this platform also have their own PC in their workshop, where they can log on to the Safety Management System with their personal user. If they are out on deck and need a procedure or checklist, they will have to go inside to get this. Contractors visiting on short term basis do not have their own defined user account in the Safety Management System, and for them availability will be more difficult. The management of the organization does not have the opportunity to check who is been actively using the Safety Management System, so they cannot know for certain who is actually using the system. There is no reward or penalty for using or not using the system, except if an unwanted incident should occur and it turns out to be caused by someone who did not follow procedure.

4.1.1. Short introductory course

All new staff on the platform has to undergo training in the Safety Management System; a two hour web based course with a multiple choice exam at the end, with ten questions. They can take the same test again and again until they reached the required score of eight out of ten points.

4.1.2. Face-to-face communication preferred

An ordinary day at the platform is characterized by routine task, whether it is meetings (for the executives) or maintenance tasks (for the operators). Executives onshore and offshore are in contact with a broad specter of people within the organization, and they also have more mediated contact than the operators. Telephone, video conference, e-mail and radio are all commonly used for communication. All informants said that they preferred face-to-face communication when this was possible, for several reasons. On the platform it was often most practical to talk directly to someone, rather than e-mail, and it was the best way to get an immediate reply and to avoid misunderstandings. One of the executives said it also had to do with the company philosophy.

2: *We are a collaborative community, and good communication with the contributor is very important. And since it is part of my job to intercept dissonance, it is important to meet people face to face.*

For mediated contact they preferred the most direct media, like telephone, offering synchronous communication so they can get an answer right away. Sometimes asynchronous communication, like e-mail, was preferred, because e-mails are stored over time and gives a traceability which can be practical when work hours onshore and offshore differs.

4.2. Vague descriptions of the Safety Management System

4.2.1. What they think the system is

When asked to describe the Safety Management System, the informants could only give vague descriptions, usually something about checklists and procedures. A typical reply from the executives was that the Safety Management System contained just about everything.

2: *It... describes how we should manage the enterprise. It is everything from philosophies, strategies and principles, to guidelines and official requirements, things that you just have to do and things that you should do.*

Table 1
Themes and sub-themes.

Theme	Sub-theme
Context	Short introductory course Face-to face communication preferred
Vague descriptions of the Safety Management System	What they think the system is What is the purpose of the system
User friendliness	When do they use it Difficult to navigate Information overload Language Creating their own solutions Finding work permits Access to procedures
Forget a lot during four weeks off duty Optimism about future improvements Possibilities for feedback	Feedback from management Feedback to management

The workers tended to downgrade it a bit.

10: Well, yeah, the management system is there, and we're supposed to use it. But when it comes to regular operations, we know the old rut and how we should do the job.

4.2.2. What is the purpose of the system

When the informants try to explain the purpose of the Safety Management System they tend to focus more on responsibility than on safety, and seem to understand the Safety Management System as a way for the management to cover their backs in case of accidents. Although they acknowledge that the Safety Management System is supposed to ensure safety, most of them are not able to explain exactly how it is supposed to do so. In short, the workers say that they need procedures and a management system, but they cannot really explain why. This has an effect on how they understand the Safety Management System as less important, and it negatively influences their motivation for use. Safety research has often focused on intentional violation. The informants in this study prefer not to use the Safety Management System and hence, do not necessarily know the procedures. The attitude is that they can do their job properly without entering the Safety Management System and check the procedures. This diminishes the respect for the procedures, in an organizational culture that allows this to happen. The workers do not perceive the Safety Management System as important for safe conduct, or at least not to the extent that the executives would prefer. Workers rather see their own knowledge and competence to do their job properly as more important for safety.

One experienced operator pointed more directly to a general decrease in unwanted incidents and an increased awareness to the use of safety equipment, like ear protection and protective footwear. This is a general notion on the development of safety thinking in offshore industry (and other industries as well), and as an experienced offshore worker this informant have observed a decline accidents and unwanted occurrences, but also a safety thinking that not only concerns accidents but also less visible risks, like long term exposure to noise and solvents. He said about his previous, older colleagues: "they're probably stone deaf today". In this light it is not surprising that most informants mentioned something about safety when explaining the purpose of the Safety Management System, although they did not specify how it ensures safety. They also saw the Safety Management System as a tool for making sure that all daily activities are being done according to internal and external standards and demands. They do not seem to underestimate the importance of safety and the need for safety measures. They just struggle to see exactly how the Safety Management System can improve safety, at least on their own behalf.

10: At the same time, it's basically the same as I've been doing all the time, in my head. In a job situation I will always do a safety evaluation, I've always done that in my head, it's just that now you're going to put it in a system. And it is to stop individuals from injuring themselves, in a way, it is to keep the idiot safe. (laughs)

The idea that you do not really need the Safety Management System if you are competent and experienced, was widespread. The executives had the impression that many workers on the platform do not use the Safety Management System but rather performed the various tasks in the manner they are used to from other places they have worked.

4.2.3. When do they use the system

The offshore personnel gave very mixed answers as to how often they use the Safety Management System. One operator said he used it every day to find procedures, while most the operators

reported using it quite rarely, maximum once a week. Most informants said that they probably were supposed to use it more often than they actually do, and they assumed that everyone were supposed to use the Safety Management System on a regular basis. They also confirmed that they thought this was important for the management in the organization. However, this was not enough for them to actually use it. The onshore executive said that offshore workers should use the Safety Management System at all times, but they were also aware that this was not the case.

1: They are supposed to use it at all times, with relation to job activities. But a lot of stuff offshore is routine jobs. So whether it is necessary to go into the system every time you gonna do a routine job, I don't think they do that.

The executives, both onshore and offshore, said that although the workers do not use the Safety Management System, they still work accordingly to given procedures and safety standards, as if the Safety Management System was redundant. Offshore operators too said that that they did not feel the need to go into the Safety Management System if they knew what kind of task they were going to perform and how it should be performed. They would rather go into the Safety Management System if they were in doubt or if they were going to do something that was not routine for them.

4.3. User friendliness

Operators and executives, onshore and offshore, said that the user-friendliness of the Safety Management System was poor. Onshore executives had suggested that the user-friendliness had not been given high priority in the developing stage, as one presupposed a certain previous knowledge with IT-systems among the workers. While it is safe to assume that the workers have some experience with using computers, one might have overestimated this competence. Another factor here is that although the operators have experience with computers, it might not be their favorite tool. After all, they did not choose a career as mechanics and electricians because they love computers. This is a background factor that might have a negative effect on their motivation for spending time in front of the computer to learn how to use the Safety Management System, and indicates that user-friendliness should be given high priority.

4.3.1. Difficult to navigate

The informants said they had problems navigating in the Safety Management System and to find the checklists and procedures they needed for the job. They said they get the feeling of going in circles, and they said it felt like "an endless loop" and "like a never-ending story". The informants said it was difficult to find exactly their role in the Safety Management System, and to find the procedures that are applicable for their role in the organization. In complex workplaces the body of procedures regulating an area of work sometimes can appear as a jungle of procedures (Antonsen et al., 2008), which one of the informants laughingly gave evidence of.

13: It's not logical at all. I was going to do a job, and I decided to follow the Safety Management System to the letter to see where it brought me. And it brought me back to the commissioning phase, that I should write reports and deliver it to commissioning. But we're not in commissioning anymore, we're done with that. We've been out on the field for over two years, producing.

One specific example of incomprehensible logic in the Safety Management System was a certain reference number which the system creates for every new document. This is a random number

which gives no indication what so ever as to what kind of document this is, and the worker need to keep track of these numbers in order to retrieve any document he has been working earlier.

The claims of difficult navigation were contrasted by an onshore executive who said that the Safety Management System should be easy to use, although the person concerned gives some self-contradictory answers.

2: That's how it is with a work process based management system, in principle it should be intuitively easier to understand than the traditional map based systems. But it requires training and knowledge.

So, the Safety Management System should be easy to use, but it also takes training and knowledge to be able to use it. The developers of the Safety Management System assume and demand a certain level of computer knowledge among the operators in order to be able to use the system as intended. But do mechanics and electricians automatically have this knowledge? Several of the operators interviewed did not seem to enjoy using computers.

11: We are used to do our job without having to use computers. So they have to explain why we should use it, give out information. Because we are perfectly able to do the job without having to sit for an hour reading documents before we start. They have to explain why we should go through all these documents. (...) Why should we sit here and read for an hour when we can just go out and do the job?

This quote points to something that several of the operators mentioned; that they would prefer to go directly to the check lists and procedures, without having to relate to the whole Safety Management System as such. The operators also sometimes contradicted themselves, in saying that it was difficult to find the procedures they needed, but that they mostly were able to find what they were looking for.

10: Yeah, with a bit of clicking through I think we should be able to find our way.

This might be a way for them to portray themselves as competent in doing their job. It also hints to that the Safety Management System is not very intuitively in use, but after some searching and fiddling about they are able to learn a few paths by heart. With this in mind, it is no wonder that the operators said it would be difficult for them to find the right procedure if they were doing a tasks which was not routine.

4.3.2. Information overload

Reducing complexity can be an important strategy to close the gap between formal and informal work practice (Reiman, 2011). A greater level of commitment and adherence to the procedures can be achieved by keeping the procedures few and simple (Antonsen et al., 2008). We have already seen how the workers complain about the complex build-up of the Safety Management System in this organization. However, this has not only to do with the build-up, but also with the increasing number of procedures. In trying to have procedures to anticipate all the situations and conditions that might occur, an organization will create a large number of rules and procedures, so that the sheer amount can make it difficult to choose which rules and procedures to activate for a specific scenario (Oltedal and Engen, 2011; Sutcliffe, 2011; Antonsen et al., 2008; Dekker, 2003; Alavi and Leidner, 2001). The sheer amount of information available in the Safety Management System can serve as a deterrent for use, both because it makes it more difficult to find exactly the information you are looking for, and because it may be discouraging to have to flip through an abundance of information to find the things you need.

13: There are too many processes and paths in there, too many owners, and it's making it difficult to find your way through it. You have to identify the job you're going to do, by choosing between several options. And you're supposed to come out again on the other side, and then the system is supposed to tell you which procedures you should use. But it is not relevant at all, because, as I said, I've tried it and it doesn't work.

Similar to an information overload scenario, a procedure overload can discourage workers from searching through the jungle of information, and an ever expanding Safety Management System will make navigating difficult. Information overload is also related to the procedures themselves, as procedures that are seen as posing overly detailed restrictions on the workers are the procedures that are being violated the most (Reiman, 2011).

4.3.3. Language

One of the more specific complaints the informants had concerned the language used in the Safety Management System. They would prefer it to be in Norwegian and not English. They also thought it was a bit "academic" English, with some difficult words and grammar they were unfamiliar with. Both operators and offshore executives mentioned this.

10: I think Norwegians have pretty good competence in the English language, but it seems to me as if those who use English a lot use a lot of words that we are not familiar with, the common people. I think they do it to impress. They write it wrong. That's what I think.

In many jobs there has in an increase in how much reading and writing skills they require, but even so, language problems tend to be ignored in risk prevention (Lindhout et al., 2012).

4.3.4. Creating their own solutions

When the formal procedures get to bothersome to deal with, workers tend to create their own informal work procedures that can be very different from formal procedures, and can over time become a central part of "the way we do things around here" (Antonsen et al., 2008). This is also the case in this organization. Some of the workers in this study have created their own solutions that they find easier and more convenient to use than the Safety Management System. One of their solutions was to simply print out a bunch of check lists and keep them in a pile, so they do not have to go into the Safety Management System every time they need a checklist. An obvious drawback is that they will not get the updates if there should be any changes on the checklists or procedures. The informants themselves acknowledged this drawback, but still found it to be the more practical solution. Another solution of the workers' own design was a specially made web page with links directly to all the documents they used on a regular basis.

17: We have this computer freak in our department, and he has made a web site for the production workers. So you just access the web page, and you find links to the various systems, and a little bit «how to do it», and it's very good.

Informal work systems can involve an erosion of control and can lead the organization into a practical drift towards the boundaries between safe and unsafe practice (Antonsen, 2009). The management of the organization later reported that the aforementioned web site had been closed down. If this really was a solution that worked, it would be interesting to see whether it could rather have been developed further or if it could give ideas for how the Safety Management System could be improved.

4.3.5. Finding work permits

A great part of the interviews was spent on things the informants did not like about the Safety Management System, but they

also did have something positive to say. For some informants the Safety Management System was a good entry gate to find work descriptions, checklists and legal demands, but they also said they would prefer it if it was more clearly stated which of the demands were invariable and where it was room for individual judgment. They also said that after all, it was good to know that all the procedures and check lists was gathered in one place and if you flip through the entire procedure, you are likely to find something that you had forgotten about.

4.3.6. Access to procedures

The informants are satisfied with the procedures and checklists in the Safety Management System. They find that the procedures are recognizable and compatible with the job they are going to do. It is mainly the way of finding them they are not satisfied with.

8: *Well, yeah, when you have it on the computer, electronically, it's easy to access, I'd say. Easy to get a hold of them, if you know what you're after and where to find it.*

The informants seems to claim that it is easy to find what they need in the Safety Management System, but only if you know where to find it. It seems to be more a matter of remembering a certain path by heart rather than a result of the Safety Management System being easy to navigate in.

10: *As I say, I know what I'm going to do, and it fits in with what it says in [the procedures].*

In other words: The procedures fit in with the job he was going to do anyway. It is not the same as saying that he actually needs to check the procedure to know how he should do the job.

4.4. Forget a lot during four weeks off duty

Executives on the platform thought that the main challenge was to establish the use of the Safety Management System as a part of the daily work routine on the platform. One of the operators said that the rotation on the platform was an obstacle when it comes to developing good routines for using the Safety Management System and for getting really familiar with it.

17: *We're working shift, we have four weeks off, and then we're on the platform for fourteen days. When you're home, you don't think about work. So the stuff you did six months ago, you kind of forget that. It's just how humans are, I think.*

With this in mind it is important that the Safety Management System is easy to use, and that the user interface is intuitive.

4.5. Optimism about future improvements

The informants, particularly the executives, often expressed a general optimism that things will improve, and that the Safety Management System will keep getting better and better. It was usually a rather vague optimism. The executives used phrases like "continuous focus" and "the continuous improvement phase", with no specifications as to exactly how things will improve, and what they need to do in order to make these improvements happen, or by which standards they should measure any potential improvement.

4.6. Possibilities for feedback

4.6.1. Feedback from management

When the informants talked about what is good about the Safety Management System they said that it functions well because of the good teamwork and high level of flexibility among the staff,

and that people have the confidence to say so if something is wrong.

12: *The part with the work permits is good, and if you're lacking a check list, or a form, then you'll get a message about it from the production and maintenance leader who approves the work permits.*

The informants pointed out that that the Safety Management System works because of the cooperation between the staff on the platform. For instance that they get notice from the operations and maintenance manager if they need another checklist to get the work permit approved. They obviously do not find this information in the Safety Management System.

4.6.2. Feedback to management

The Safety Management System is mostly one-way communication, but here is a possibility for two-way communication in the system. If an operator finds that something in a procedure or checklist should be changed, he can register an observation in the system. Not everyone was aware of this, and those who had registered an observation, had different experiences. Onshore executives said it was a quick process to change things in the Safety Management System, but offshore operators have had different experiences with this. Some said that they had registered observations and that changes were made accordingly. Others said that they had registered observations but nothing happened and they did not get any information why. Others again did not know about the possibility for registering observations.

5. General discussion

The IT-based Safety Management System is a socio-technical system containing procedures, checklists, documented experiences, best practices, and expert references. It is supposed to function as a manifestation of the organization's safety culture, and the purpose is to control the hazards that can affect workers' health and safety, to maintain risk within an acceptable range in the operations of any organization, and to help the organization meet the regulatory requirements, but also knowledge transfer; the accumulation and diffusion of organizational experience. This is a lot to do for one management system, and as we have seen it does not quite live up to the ambitions. One way of improving the results would be to regard the Safety Management System not merely as a tool, but as a form of communication that requires interpretation. The perspective will have an effect on how Safety Management System is developed and used. The safety standards and work procedures in this company have been designed at an executive level in the organization, and then communicated to the lower level in the organization which applies them. The managers perceive the system as a tool, and as a tool it does not require interpretation, but the Safety Management System should rather be seen as a media text, as a part of the organization's internal communication. It is a communication system, with mediated messages traveling from the top levels of the organizational hierarchy downwards to the lower levels. This has implications for how the Safety Management System should be constructed, and how the training should be.

Dekker (2003) gives an account for two different ways of thinking about Safety Management Systems and procedures. Procedures are usually seen as protective mechanisms against human error, but one might also see them as a way for people to help structure activities across roughly similar but subtly different circumstances (Schuman as referred to in Dekker, 2003). This adaption of procedures is an activity requiring cognitive skills on behalf of the worker in judging when and how to adapt. In this study it seems

that the management in the organization expects the employees to check the procedures every time, for every little task, and it is easy to see that this is unpractical and time-consuming. However, if one opts for the other way of thinking there are still many unanswered questions as to when the procedures should be used, how they should be used, and which parts should be written in stone and where should be room for the employees to make a professional evaluation of the situation. This is still something that every organization must figure out to get a good balance between thorough procedures and flexibility. A related question is to what extent and in which way the employees should be involved in the development of the procedures and Safety Management System. Employee involvement will be rewarded by an increased feeling of ownership to the procedures. When the employees get the sense that the procedures have originated from themselves, and not from some pencil pusher in an office, it will have a positive effect on their use of procedures. This does not mean that the operator should develop the procedures on their own. There are limitations as to how much every individual employee can be involved in the development of the procedures, with respect to money and time, and with respect to what kind of competence is needed in order to develop good procedures and a thoroughly thought-through Safety Management System. Development of procedures requires thorough knowledge of existing rules and regulations, and extensive testing of procedures before they are being implemented. Some of this can only be acquired on an expert level. Blakstad et al., suggests that complex systems one could use a combination of a deductive top-down and a deductive bottom-up approach (Blakstad et al., 2010). Hence, operators could be included in a team together with IT-experts and Human Factors experts. Further one could utilize the Safety Management System as a communication system by developing the possibility for two-way communication. In the company researched here the system already includes the possibility for feedback from operator to management level, but this has not been very well developed and many of the informants were not aware of this possibility.

Human Factor-analyses should be a part of all phases of development of procedures and Safety Management Systems, to assure user friendliness, enhance performance, and increase safety (Deacon et al., 2013; Wickens et al., 2004) although one must keep in mind that even if the procedures have a high degree of user friendliness, this does not automatically guarantee compliance (Lawton, 1998; Dekker, 2003). In this study it seems that the developers of the Safety Management System have overestimated the users' computer competence. The level of computer competence within the user group must be taken into account when Safety Management Systems are developed. It is also necessary to refine the language used to make it easier for the users to comprehend.

6. Sum up and conclusion

Safety standards and work procedures should be analyzed as a part of the communication within the organization, not just as a tool. Executives and workers relate to the management system very differently, and this has an effect on the communication. What are called "distortions" or "misunderstandings" arise from the lack of equivalence between the two sides in the communicative exchange. While executives perceive the management system as a fundamental tool for safe conduct, the attitude among the workers is that they can do their job properly without the Safety Management System. The workers acknowledge the need for safety measures, but they do not see how the Safety Management System is supposed to ensure safety. This has an effect on how they understand the Safety Management System as less important, and it negatively influences their motivation for use. Therefore, the

training should focus on meaning to make sure that the users understand the purpose of the Safety Management System, and aim to establish the ability to apply and adapt procedures in good judgement as a part of the workers' professional identity.

This is also a human factors issue, as it relates to the interaction between human and the system, and to cognitive thinking and knowledge-related aspects. Human factors should be applied at an early phase in determining how the Safety Management System and the procedures should be developed to ensure user friendliness. Onshore executives suggested that the user-friendliness had not been given high priority in the developing stage, while the offshore workers said they had problems navigating in the Safety Management System and to find the checklists and procedures they needed. To better match the user interface to the workers, a user analysis is necessary to identify the different types of users and how the systems and procedures should be designed in order to be a resource for the users. The users must also be allowed to give feedback on their experience with the different procedures. User involvement in all phases of the development phase lays the foundation for the procedures to represent accumulated experience. This argument loses credibility when the users are not involved.

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End User Involvement in the Development of Procedures and Safety Management Systems

Thomas Wold^{*a} and Karin Laumann

Department of Psychology, Norwegian University of Science and Technology (NTNU). Trondheim, Norway.

Abstract: IT-based Safety Management Systems contains procedures, safety standards, checklists and descriptions on how different tasks should be performed, and are usually designed at an executive level in the organization, and then communicated to the lower level in the organization where they are being applied. This paper presents data collected from qualitative interviews with executives and operators from two companies in the gas and petroleum industry. The executives generally regard Safety Management Systems as important tools for all work in hazardous environments, while the operators weren't that enthusiastic. How can end user involvement in the development phase of procedures and Safety Management System improve use? A central argument is that Human Factors must be involved as early as possible in the development phase, and that operators need to understand the purpose of the management system in order to use it as intended. The informants that had been involved in the development of the procedures at least to some extent, felt an ownership to the management system, while the ones who hadn't been involved at all felt no ownership to the management system, and did not see the purpose of it.

Keywords: Safety Management System, Procedures, Communication, Human Factors

1. Introduction

In industries operating in hazardous environment there has been a development towards controlling the daily workflow through various forms of management system. IT-based Safety Management Systems contains procedures, safety standards, checklists and descriptions on how different tasks should be performed. Safety standards and work procedures are often, but not always, designed at an executive level in the organization, and then communicated to the lower level in the organization where they are being applied. The purpose of using IT-based Safety Management System is to code and share best practices, create corporate knowledge directories and to create solid knowledge networks within the organization. Executives generally regard Safety Management Systems as important tools for all work in hazardous environments, while the operators aren't always that enthusiastic. The questions investigated in this paper are:

- 1) How was Human Factors involved in the design of a safety management system for one petroleum company?
- 2) How does use of Human Factors knowledge increase the operators' satisfaction with and use of the safety management system?

^a Thomas Wold: Thomas.Wold@svt.ntnu.no

2. Theory

2.1. Safety Management Systems

Safety management refers to the actual practices, roles and functions associated with remaining safe [1]. Safety management is “the policies, strategies, procedures and activities implemented or followed by the management of an organization targeting safety of their employees” [2, p. 283]. A Safety Management System is hence a formalized way of dealing with these practices, roles, policies and procedures. Safety Management Systems can be seen as “a socio-technical system for knowledge transfer [...], through documented experiences, best practices, and expert references” [3, p. 2]. Safety Management Systems are integrated mechanisms in the organizations, and the purpose is to control the hazards that can affect workers’ health and safety [4, 5], to maintain risk within an acceptable range in the operations of any organization [6, 7], and to help the organization meet the regulatory requirements [4, 7, 8, 9]. This is not only a matter of coordinating between tasks, but also the accumulation and diffusion of organizational experience, and to turn tacit knowledge into explicit and shared knowledge [10]. There is also a general agreement that Safety Management Systems is a means to change safety management from being reactive to being proactive [11], and anticipating hazardous situations before they occur, and not just acting after an accident has occurred, or phrased differently; to protect against human error [8, 12, 13, 14]. There is also the matter of defining legal responsibility if incidents should occur [8].

Safety Management Systems in professional organizations has in several cases been less successful. One of the reasons is that in the development and implementation phases the emphasis has been mainly on the technical requirements, ignoring the social and cultural facets of knowledge management [5, 15]. It is also because designers tend to focus primarily on the technology and its features, and forget to look at the use of the system from the human point of view [16].

2.2. Human Factors

According to the European Committee for Standardization human beings should be considered as “the main factor and an integral part of the system” when work systems are being designed (17, p.3). This includes the work processes and the work environment. Several researchers stress the importance of giving high priority to the action of human beings when procedures are being designed [18]. When experts design systems, they are not always able to predict what kind of difficulties other people will experience when using their system. The experts are so familiar with their own system, they know very well how it works and how to control it, that it comes natural for them, but they often forget that the users don’t necessarily have the same familiarity with the system. The users don’t have the same mental models as the designers, and it may also be that they don’t interact with the system frequently enough to develop the same mental models [16]. Another factor is that experts are often distributed across various locations which makes it difficult for them to have general knowledge of the installations and what impact different components might have on each other [19]. A related factor is that onshore workers sometimes lack awareness of offshore processes; they don’t have the same direct sensory experience as offshore workers, and they don’t have the tacit knowledge and impressions gained while working on the installation [19].

Well intended efforts to promote safety may marginalize the local and system specific knowledge inherent in the organization, and safety professionals must be aware of this. Since employees close to the work are the best qualified persons to make suggestions for improvements, they can be consulted before making final decisions, especially for those decisions that affect the employees. A successful approach on many occasions has been to incorporate users as actual members from beginning to end, although one must be aware that users working with design teams might become so familiar with how the designers think, and so familiar with the system they are designing, that the same problem arises. Therefore it is advisable to bring in a different group of users for the various stages of usability testing [16]. This empowerment of workers provides them with authority, responsibility and accountability for required decisions and ensures that both employees and managements are involved in setting goals and objectives [2]. There is also evidence to suggest that a greater level of commitment and adherence

to procedures can be achieved by keeping procedures few and simple and by emphasizing broad and direct worker participation in the process of implementing the procedures [8].

An important part of the design sequence is to analyze the typical user in order to ensure that their needs and the demands of the work situation are understood. One need to clarify the following; who users are, what main functions are to be performed by the system, what are the environmental conditions under which the system will be used, and what are the user's preferences or requirements for the system [16]. This particularly applies to the informations-processing characteristics of the system. Insights from human factors can be very useful here, as it relates to the interaction between human and the system. The precise boundaries of the discipline of human factors cannot be tightly defined but are closely related to ergonomics, engineering psychology, and cognitive engineering [16]. Human factors have often been concerned with the physical aspects of work, but the scope also includes cognitive thinking and knowledge-related aspects and mental interactions with the system [16, 19, 20]. Human factors revolves around the central importance of the user, and the goal of human factors is to enhance performance, increase safety and increase user satisfaction. This includes the communication and cognitive processes involved in using the system. If human factors methods and principles are applied as early as possible in the development of a system; in predesign analysis, technical design, and final test and evaluation, many of the human factors deficiencies will be avoided before they are inflicted on systems design [16].

The European Committee for Standardization state that ergonomic effort should be greatest at the beginning of the design process, as it is here the most important decisions that have consequences in the design are made [17]. This goes for human factors methods and principals as well, which should be applied in all stages of the design: predesign analysis, technical design and final test an evaluation [16]. Hence, human factors should be applied at an early phase in determining how the Safety Management System and the procedures should be developed, and how the staff training should be. Human factors principles are too often either left out entirely, or brought in too late in the development process when the product design is already completed and handed to a human factors expert. This only places everyone at odds with each other [16]. Rather, human factors must be a part of the process from the very beginning of the planning and development of procedures and Safety Management Systems in order to get a balanced development of the technical and human aspects [16, 20]. To achieve this it is important that workers are allowed to be involved in the design process [17].

2.3. Communication

Any Safety Management System, no matter how it is constructed, is communication. It can be convenient to pretend that this is one-way communication, but it's not, because the user interprets the information in the Safety Management System and turns it into knowledge, adding his or her prior experience. This is also part of the communication process which must be addressed as part of the user analysis, to consider the cognitive characteristics of the user. The cognitive strengths of humans must be emphasized, but also how operators feel and interact with operations and management and designed objects [21]. For example, a Norwegian study showed that the workers often thought it was difficult to find the relevant governing documentation within the safety management system, so they needed to use more effort and time in order to find what they needed [22]. This makes it unnecessary difficult for the workers to find the information they need in order to fulfill their tasks and to make the necessary decisions. Not only shall machines be designed to suit the physical abilities of the expected user, but instructions and procedures shall be designed to fit their mental abilities; the cognitive, informational end emotional processes in the human being [21].

If this is not done successfully, we have several studies indicating that workers will deviate from the procedures if they know a better way of doing it [13, 23, 26]. When workers deviate from procedures, one must either figure out how to ensure compliance, or see if they might have a good reason for deviating from the procedures. Have they for instance actually found a better/safer way of doing the job than the procedures prescribe? Safety Management Systems are living systems and should always open for evaluation, adjustment and changes. A Safety Management System is never completely finalized in its making. Ideally it should always be developed on the basis of new experience, in order

to replicate success. Three ingredients are particularly important for a successful match between procedures and practice: There should be feedback from the lower to the upper tiers of the organization, the adjustment of procedures should be based on the views of those directly involved, and the time interval between worker feedback and implementing changes should be as short as possible [8]. In existing system one must study the interaction between human and system to find to identify various problems and deficiencies [16].

2.4. Tacit knowledge

In any organization there will always be tacit knowledge, and much effort is made to turn tacit knowledge into explicit and shared knowledge, and to make invisible work processes visible and transparent. If those who actually perform the work are the only ones who knows how it is done, the ability to account for this invisible work and the tacit knowledge that accompanies it, can strengthen the organization's performance significantly [10]. However, tacit knowledge can be so complex that it is difficult to articulate in a way that makes sense, and many professions demand a certain experience in order to be able to make complex considerations [27]. This is not to say that tacit knowledge needs to remain tacit. With Choo's definition of tacit knowledge as "the personal knowledge that is learned through extended periods of experiencing and doing a task, during which the individual develops a feel for and a capacity to make intuitive judgments about the successful execution of the activity" [28], it is clear that this type of knowledge can also be made explicit and brought forward to other workers who lack the experience, which the management systems is an attempt to systematize. This way the separating lines between tacit and explicit knowledge will be moved, so that knowledge that was tacit yesterday is explicit today [27]. This can be done, at least to some degree. It's easier said than done, but it naturally involves the workers in a dynamic communication with the managers and the safety experts.

3. Method

3.1. Subject

The empirical data is collected by conducting qualitative in-depth interviews with 27 employees in two different companies in the Norwegian oil and gas production sector, hereby named Company A and Company B. The first three informants from Company A were onshore executives who have had an active role in the development of the company's Safety Management System, and these were interviewed in a preparatory study. In the same company five offshore executives and ten offshore workers, representing different disciplines; mechanics, electricians, logistics and lab technician, were interviewed on board at the oil and gas producing installation. The third round of interviews was in conducted on land, with nine foremen and offshore installations leaders in Company B, a company that provides contract workers to an oil and gas producing company (not Company A).

3.2. Data-collection process

The interviews were conducted in a separate room during the normal working hour of the informants. The interviews followed a semi-structured interview guide, where certain topics were planned in advance, but also allowing for the informant to bring new topics to the table, and also allowing for the structure for each interview to be different according to how the informant associated the various topics. The interview started off by letting the informants tell about their routines for an ordinary work day and to describe the Safety Management System and the purpose of it. The questions then became more detailed about which procedures they used and in which situations, how they learnt about the Safety Management System, about the user friendliness of the system, shortcomings and advantages. Each interview lasted for 30-45 minutes, with a few exceptions. The interviews with the offshore executives generally lasted longer than the interviews with the workers. The interviews were conducted and transcribed by the first author of this paper.

3.3. Data analysis

The data was analyzed using a thematic analysis. Thematic analysis offers a theoretically-flexible approach to analyze the major themes to be found in interviews (or other qualitative data) [29, 30, 31].

The first step was familiarizing with the data by transcribing the audio interview files. The transcribed material was then fed into the software program NVIVO 10 and coded into many categories and sub-categories (nodes is the term used in NVIVO 10). This first round of coding was rather broad, where each interview segment could be coded in several categories, where relevant surrounding data was kept to keep track of the context. After the initial coding some categories were developed into themes while other categories were too small to qualify as themes. The themes were not necessarily the same as the topics in the interview guide, some were of course, but new themes also arrived during the interviews, and some themes emerged when looking at certain keywords mentioned by some of the informants, and by looking at in which context they mentioned these words. After re-reading the coding of each theme, some themes collapsed into each other whilst other themes were broken down into separate themes. The initial codes were partly derived from the interview guides, but several new and sometimes unexpected codes emerged from the interview material. What eventually became themes was mainly guided by the interview material, and not theory driven.

4. Results and discussion

4.1. Purpose

One important basic factor in using a management system is to understand the purpose of it, and the basis of the procedure and its intended higher-level goals. The informants who were able to say something about the background for the development of the procedures and the purpose of the Safety Management System, had a much better use of it than those who couldn't.

In Company A, the Safety Management System was developed by an external consulting company. The consultants had a few meetings with the top management in Company A, but end users weren't involved in testing until it was almost time to launch the management system. The head of the designers said that user friendliness was not given high priority.

A3: Not really. User friendliness is... well, it is a prerequisite for the management system as a whole that the user can click his way through a browser.

They did not involve Human Factors in the development of the management system, but had mainly a technical focus. This was partly due to financial and time restrictions, but also because the procedures had already been developed separately by a different company.

A3: We met a forest of procedures that had been developed by another company. And we had to make a superstructure that should match all those procedures. And what you discover when you start to adjust it, is that it doesn't fit.

It will be better to have a more coherent process when developing the procedures and the management system, and to involve Human Factors and end users in the development. The executives in Company A acknowledged that the workers didn't have any sense of ownership to the management system and that this was a problem. The only informants in Company A that felt ownership to the management system were onshore executives who had been involved in the development of the system. The operators in Company A were not able to explain the purpose of the Safety Management System, and hence, they didn't see the point in using it. They acknowledged that it was necessary to have a management system, but couldn't explain why. They said that it had something to do with safety, but saw their own experience and competence as more important for safe conduct.

A11: We are perfectly able to do the job without having to sit for an hour reading documents before we start. They have to explain why we should go through all these documents. (...) Why should we sit here and read for an hour when we can just go out and do the job?

When the operators in Company A tried to explain the purpose of the Safety Management System they focused more on responsibility than on safety, and saw the Safety Management System as a way for the management to cover their backs in case of accidents. This has an effect on how they understand the Safety Management System as less important, and negatively influences their motivation for use. In contrast, foremen and offshore installation managers in both companies saw the procedures and the Safety Management System as a collection of best practice principles guided by many years of collective industrial experience. The informants in Company B often worked as contract workers for a large gas and oil producing company, using the management system of the hiring company. But Company B also had their own management system, a smaller entity where several of the informants had been involved in the redevelopment of. This has given them a better understanding of the basic idea of having a management system as a storing and categorising of experience to form a knowledge foundation to evaluate the line of action for a new task.

B24: It's the best of [the company's] 40 years of experience in oil production. (...) What they have gathered there, is the best praxis. How to perform a task and how to relate to HSE and everything we're in touch with. But it is never elaborative. In the end it's still we that have to put the final piece to the puzzle, because it is a lot of good stuff in there, but it can't tell you everything. It doesn't tell you what the weather's going to be like that day, for example. You still have to think.

Antonsen has shown how seamen often interpret attempts to govern work by formal rules as a negation of the seamen's professional expertise. This will no doubt affect their respect for and their motivation for using the formal procedures. In addition, formal procedures have their origin in onshore organizations, like regulatory authorities and oil companies. This is outside the seaman community, or the ones doing the practical work, and this influences how the seamen interpret the formal safety management. The seamen in Antonsen's study saw the procedures as based on the theoretical knowledge of some "office worker", and not as based on the practical knowledge possessed by competent seamen, and for them this undermines the legitimacy of formal procedures [12]. By involving the workers in the development of the procedures they will not see it as a negation of their own competence, but rather as an appraisal of their experience and competence, and it will increase ownership to the procedures.

4.2. Language

One of the more specific complaints the informants in Company A had concerned the language used in the Safety Management System. They would prefer it to be in Norwegian and not English. They also thought it was a bit "academic" English, with some difficult words and grammar they were unfamiliar with. Both operators and offshore executives mentioned this.

A10: I think Norwegians have pretty good competence in the English language, but it seems to me as if those who use English a lot use a lot of words that we are not familiar with, the common people. I think they do it to impress. They write it wrong. That's what I think.

User tests and user involvement will no doubt help to avoid misunderstandings caused by unfamiliar grammar and vocabulary.

4.3. Adaption

In order to operate safely it is necessary to be able to adapt the written procedures to local and immediate circumstances [8, 13, 23]. The informants in Company B pointed to the general purpose and the basic idea of a management system, as a storing and categorization of experience that forms a basis that should be used when evaluation how a specific task should be carried out. Note that they express that individual evaluation is still necessary.

B26: It's a bit like the Bible, you know. (...) You get an answer, but you have to interpret that answer. It's not very unambiguous. (...) Some places it is very unambiguous, but other places it might be a bit uncertain, and you can experience that they interpret it differently on different installations.

In contrast, the operators in Company A said that they had to do their own evaluations as to how to perform a certain task when the written procedures were useless, instead of letting the procedures form a basis for the decision making process. Informants from both companies valued the workers experience and competence, but in a slightly different way. The informants in Company A saw experience as necessary to compensate for flaws in the procedures were, while the informants in Company B saw experience as necessary to use the procedures as a basis for their evaluation on how a job should be performed.

The informants in Company B saw experience as an important ingredient in cases where the management system didn't give elaborative information. They expressed the opinion that there will always be some situations where the procedures are not entirely elaborate or where they are not entirely in accordance with reality, and in these cases they must adapt the procedures based on their own experience and competence.

B27: It doesn't always say in the management system, but it's a bit like based on experience and such, so we say to each other "shouldn't we rather do this and that to be a hundred percent sure", you know. That's how it is. Based on experience, really.

With management systems and procedures there will always be a question how detailed they should be and how strict the guidelines should be. In this respect it is important that the management system gives unambiguous information as to where the procedures must be followed to the letter and where there is room for adaptations [13]. Anyhow, the definitive responsibility for safe conduct still lies on the operators who perform the task.

4.4. Informal procedures

Sociological studies of work very often reveal that workers tend to create their own informal work procedures that can be very different from formal procedures, and the existence of informal procedures that guide decisions and actions are a central part of the popular definition of organizational culture as 'the way we do things around here' [8]. This particularly happens when the formal procedures get to bothersome to deal with. In Company A some of the workers had created their own solutions that they found easier and more convenient to use than the Safety Management System. One of their solutions was to simply print out a stack of check lists and keep them in a pile, so they don't have to go into the Safety Management System every time they need a checklist. An obvious drawback with such a solution is that they won't get the updates if there should be any changes on the checklists or procedures. The informants themselves acknowledged this drawback, but still found it to be the more practical solution. Another solution of the workers' own design was a specially made web page with links directly to all the documents they used on a regular basis. There is a potential here to pick up the experience made by the workers, and utilize them in the ever ongoing updating and development of

the management system. This is also in accordance with the general guideline that the operator should feel that they have retained control over the system [17].

5. Sum up and conclusion

Procedures and Safety Management Systems are usually developed by management experts who are not involved at the operational level. A key challenge here is to involve the workers in the development of the procedures and Safety Management System. These must be constructed so that they increase ownership of work, and not decrease ownership of work. One should utilize the competence and experience of the workers when developing the procedures. The workers should also have the opportunity to give feedback on how useful the procedures and the management system are. The communication that a Safety Management System constitutes is mainly a linear communication from the upper tiers of the organization to the lower, but one should not forget the cognitive process that takes place when workers interpret and adapt the given procedures. There should also be feedback travelling the other direction as well, so that that adjustments or procedures can be based on the views of those directly involved. It is also important that the time interval between worker feedback and implementing changes is as short as possible.

Broad and direct worker participation in the process of implementing the procedures has been shown to lead to a greater level of commitment and adherence to procedures. Employee involvement will be rewarded by an increased feeling of ownership to the procedures. It will have a positive effect on the employee's use of the procedures when they get the sense that the procedures have originated from themselves, and not from some pencil pusher in an office. However, there are limitations as to how much every individual employee can be involved in the development of the procedures, with respect to money and time, and with respect to what kind of competence is needed in order to develop good procedures and a thoroughly thought-through Safety Management System.

Human Factors-analysis should be a part of the development of procedures and Safety Management Systems to assure user friendliness. Human factors revolves around the central importance of the user, and the goal of human factors is to enhance performance, increase safety and increase user satisfaction. This includes the communication and cognitive processes involved in using the Safety Management System. If human factors methods and principles are applied as early as possible in the development of a Safety Management System, in pre-design analysis, technical design, and final test and evaluation, many of the human factors deficiencies will be avoided before they are inflicted on systems design.

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Optimizing of program for training employees in using Safety Management Systems in the petroleum industry

Thomas Wold & Karin Laumann
Center for Safety and Human Factors
Department of Psychology
Norwegian University of Science and Technology

Corresponding author

Thomas Wold
Center for Safety and Human Factors
Department of Psychology
Norwegian University of Science and Technology
NO-7491 Trondheim
Norway
E-mail: Thomas.wold@svt.ntnu.no
Mobile Phone: +47 99 50 62 89

Abstract

In the industry and in the safety science, a lot of attention has been given to the technical and legal aspects of procedures and Safety Management Systems, and less attention to the communicational aspects and the training aspects. In order to develop the Safety Management Systems further and to improve the use of them one should increase focus on staff training. Through a literature review and qualitative interviews with offshore workers, this paper presents a discussion and advice on how training in Safety Management Systems can be optimized.

Safety Management Systems and work procedures should be understood as a part of the internal communication in an organization, not just as tools. This has implications for how the training should be, as it effects how the workers interpret and use the procedures. The training should make sure that the workers understand the purpose of the Safety Management System. Training should address the structure and the purpose of the procedures, but should also focus on the limitations of the system.

Theoretical training is necessary, but should be combined with practical exercises and simulation. Repetition and feedback are also essential elements in training.

Optimizing of program for training employees in using Safety Management Systems in the petroleum industry

Introduction

Many industry companies operating in hazardous environments control the daily workflow using an IT-based Safety Management System containing procedures, safety standards, checklists and descriptions on how different tasks should be performed, in order to streamline human action, to decrease risk and increase productivity. In the industry and in the safety science a lot of attention has been given to the technical and legal aspects of the various procedures and Safety Management Systems, and less attention to the communicational aspects and the training aspects (Wold & Laumann, 2015). An important question that this paper aims to answer is: How can training and a communicational perspective improve the use of Safety Management Systems?

The purpose of using IT-based Safety Management System has typically been to code and share best practices, create corporate knowledge directories and to create knowledge networks for organizations (Wold & Laumann, 2015). A Safety Management System is a formalized socio-technical system that relates to the practices, roles, policies and procedures associated with remaining safe, but also for knowledge transfer and documentation of best practices and expert references (Chen & Chen, 2012; Vinodkumar & Bhasi, 2011; Santos-Reyes, & Beard, 2009; Antonsen, Almklov & Fenstad, 2008; El Koursi, Mitra & Bearfield, 2007; Norheim & Fjellheim, 2007; Hale, Heming, Catfhey and Kirwan, 1997).

Several studies suggest a correlation between employees training, safety culture and the implementation of Safety Management Systems (Dahl, 2013; O'Hara, 2000). Training is recognized to be a key element for safe workplace (Bottani, Monica & Vignali, 2009). Conversely, lack of instructions or appropriate training is suggested as one of the main factors in the organizational and management systems that predispose workers to act unsafely. Investing in the workers' knowledge of procedures is necessary for progress on safety, as non-compliance with rules and procedures has been a central contributory factor in many incidents in high-risk industries (Dahl, 2013; Andersen, 2013; Korsvold & Lauvsnes, 2011; Bottani, Monica & Vignali, 2009; Thunem et al., 2009; Karish and Siokos, 2004; Dekker, 2003; O'Hara, 2000).

Many professional organizations have mainly focused on the technical requirements in the development and implementation of Safety Management Systems, and paid less attention to the social and cultural facets of knowledge management

(Vinodkumar and Bhasi, 2011; Rai, Maruping and Venkatesh 2009; Alavi and Leidner 2001; Cox and Cheyne 2000). A training program should not only focus on the technical aspects of the Safety Management System, but also on the cultural and social aspects of a communication process.

Two studies will be presented here, and the purpose is to discuss and give advice about how to optimize training on Safety Management Systems.

Study 1 is a literature review focusing on training in organizations, definitions of training, and different types of training and factors that effect training outcome. The purpose of this study is to investigate which types of training is most appropriate for Safety Management System.

Study 2 is an empirical study on the training given for the Safety Management Systems in two organizations in the petroleum sector. The purpose of this study is to see what kind of training the employees undergo, how they perceive this training and how it effect their use of the Safety Management System, and to discuss strengths and weaknesses with the training program they use.

Study 1: Literature study

In the literature study various books and papers on training were examined. Some papers dealt with training and cognition in more general terms, while others more specifically dealt with in-house training in organizations, both industrial organizations and other types of organizations.

Method

A literature search was done in library and journal resources within various academic disciplines relevant to safety science and training; pedagogy, psychology, organizational theory, human factors and human resource management and development. The papers collected were a mix of empirical studies, meta-studies and theoretical reviews. The main focus is on books and papers published after 2000, with a few exceptions. All the literature reviewed had a basic assumption that staff training in general improves performance.

Results and discussion

According to the European Committee for Standardization all implementation of new work system shall include a careful introduction to all people concerned, including necessary information and training (EN ISO 6385:2004: p.9). It is obvious that there must be some sort of training for all workers in the gas and petroleum

industry, so the question is rather how the training should be organized and what it should focus on.

Definitions of training

Common definitions of training states that it involves planned and systematic activities with the purpose to promote the acquisition of knowledge, skills and attitudes (Salas et al., 2012; Grossman & Salas, 2011). Multiple studies reveal that training is in general effective in terms of improving organizational performance as a whole, and more specifically, to improve cognitive and interpersonal skills, both declarative knowledge and procedural knowledge, and knowing when to apply a specific knowledge or skill and the expertise to adapt knowledge to various conditions (Aguinis & Kraiger, 2009; Sitzmann, Kraiger & Kanar, 2009; Arthur et al., 2003). Training should not only be viewed as an expense, but as an investment in human capital (Salas et al, 2012). Training always comes with a cost and needs to be justified as an investment in terms of increased productivity, profit or safety (Salas & Cannon-Bowers, 2001).

Types of training

There are various types of training which must be considered with regards to costs and training outcome: classroom training, web based training, simulation training, on the job training and mental training.

Classroom training

Traditional lectures and classroom training has had a reputation for being unengaging and inefficient, but a meta-analysis by Sitzman et al. (2006) showed that this is not entirely true. Although web based training was 6 % more effective than classroom training for teaching declarative knowledge, there was no difference in effectiveness for teaching procedural knowledge (Sitzman et al, 2006). It is also possible that the small advantage of web based instruction may be a result of novel training strategies, and not the medium per se (Aguinis & Kraiger, 2009; Sitzman et al., 2006). There are multiple newer strategies for classroom training, for example discovery training, error training and training in metacognitive skills, each with the potential of encouraging deeper initial learning and greater transfer of training (Sales et al., 2012). Even the old fashioned and reputedly boring lecture has proven to be quite effective in training several types of skills and tasks, often in conjunction with other training methods (Arthur et al., 2003).

Web-based training

Technology-based training, in particular web-based training, is increasingly being used, either instead of or in support of more traditional forms of training (Salas et al., 2012; Patel, 2010; Aguinis & Kraiger, 2009). Web-based training is often considered cost effective, although the increasing implementation of web-based training is often

happening without much reliance on the science of training, and the cost-effectiveness is often simply taken for granted (Kraiger, 2003; Bell & Kozlowski 2002; Salas & Cannon-Bowers, 2001). Web-based methods saves time and money spent on going to training, which makes web-based training well suited for companies with dispersed employees, but one should keep in mind that this also involves increased costs in investments in technology and technology support (Salas et. al, 2012; Bell & Kozlowski, 2002). According to survey data training costs remain relatively constant when an organization shifts from face-to-face to technology-based methods (Patel, 2010).

Web-based training is most effective when it offers immediate feedback and when trainees are provided with control, (Sitzman et al., 2006), but will not be effective unless instructional techniques are designed so that they assist the trainees in making use of the control they are given (Salas et al., 2012; Bell & Kozlowski, 2002). Several studies shows that individuals perform better when self-regulation and learner control is supplemented with some form of guidance (Salas et al., 2012; Sitzmann, Kraiger & Kanar, 2009; Bell & Kozlowski, 2002). It is more efficient to guide individuals through computer-based instruction than to provide either total self-regulation or total program control (Bell & Kozlowski, 2002). Though web-based training in general has been proven to result in slightly greater learning than classroom training, the effects for the two types of training were more or less the same when instructional principles were held constant (Salas et al., 2012; Sitzman et al., 2006). A recurring problem is that many new training techniques are merely used as a new delivery media, as a computerized version of traditional training (Bell & Kozlowski, 2002). Well-designed instructions are of greater significance than choice of delivery mode, so plans to implement web-based training should be based on a consideration whether the content can be learned effectively this way (Salas et al., 2012; Aguinis & Kraiger, 2009; Bell & Kozlowski, 2002).

Mental training

Mental training, or mental practice, is “the symbolic rehearsal of a physical activity in the absence of any gross muscular movements” (Richardson, 1967, p. 95), in other words to rehearse a task cognitively, not physically, for instance when an athlete visualizes the steps required to perform the task as a part of the preparation (Driskell, Copper & Moran, 1994). Mental training should be distinguished from the broader term mental preparation, which includes a variety of cognitive or emotional preparation prior to performance; techniques like self-efficacy statements, attention focusing, psyching-up strategies and so on. The term mental training should be reserved for training techniques where “the procedure required to perform a task is mentally rehearsed in the absence of actual physical movement” (Driskell, Copper & Moran, 1994, p. 481). This form of mental simulation of tasks can increase resilience

by building capabilities to cope with disturbances once they appear (Sutcliffe, 2011). Mental training is generally thought to have a positive effect on performance, although several moderators need to be taken into consideration. One should also be aware that mental training cannot replace physical training; mental training helps to rehearse behaviours and to aid recall, but does not offer direct knowledge of results or visual feedback (Driskell, Copper & Moran, 1994).

Mental training has proven to be effective both for tasks that require mental or cognitive capacities and for physical or motor tasks as well, although the effect of mental practice is stronger the more a task involves cognitive elements (Driskell, Copper & Moran, 1994). Moderators to be considered here is retention interval, experience level and duration of practice. Retention interval refers to the period between the last mental training period and the actual performance of the task. The effect of mental training will be weaker the longer the retention period is. In experimental studies the measured effect of mental training on behaviour was reduced to a half within the course of two weeks, and was nearly gone after three weeks (Driskell, Copper & Moran, 1994). The experience level of the trainees also matter for the effect of mental practice. In the research literature it has on the one side been suggested that mental training is more effective in early stages of learning, while others have argues that trainees with prior experience will benefit the most from mental practice (Driskell, Copper & Moran, 1994). Experimental studies have concluded that both novices and more experiences workers benefit from mental training, though with some nuances: Novice workers benefit more from mental practice on cognitive tasks than on physical tasks, while for experienced workers mental practice was equally effective regardless whether the tasks were of a cognitive or a physical nature (Driskell, Copper & Moran, 1994). So it seems as if the motor skills of a physical tasks has already been learnt, mental training without additional physical practice and feedback will be sufficient to improve performance, making it very a cost effective training technique. Mental training is an effective strategy to reduce skill decay (Arthur et al., 1998), but one should be aware that more extensive mental practice does not necessarily lead to more learning. Researchers have cautioned that too much mental practice can result in a loss of motivation and concentration, and might be counterproductive (Corbin, 1972). Relatively short mental training sessions, approximately 20 minutes, have proven to be more effective than longer sessions (Driskell, Copper & Moran, 1994). It is noteworthy that this relates to the duration of mental training trials, not the number of repetitions during a longer period of time.

Simulation training

Simulation training has been around for decades, and has particularly been used by the military and the airline industry and increasingly so also in health care, with

good results (Salas et al., 2012). Technological innovation combined with declining costs has contributed to an increase in the use of simulation training in various areas, like medicine, maintenance, law enforcement, and emergency management settings (Salas et al., 2012; Bell & Kozlowski, 2002). Well-designed simulation training can enhance learning by creating a safe environment for learning by trial and error, instruction and detailed feedback, particularly for tasks where actual mistakes can cause serious injuries or damage to equipment (Salas et al., 2012; Bell & Kozlowski, 2002; Arthur et al., 1998). The purpose of simulation training is to provide realistic training by using a working representation of reality; a model of process that is abstracted, simplified or accelerated (Galvao, Martins & Gomes, 2000). The model is not an exact replication of reality. According to Salas et al. (2012) what matters is not the physical fidelity level of the simulator, but the relevance of the content for job performance, the psychological fidelity so to speak. This includes a wide range of low-fidelity simulation, for instance role-playing, and high-fidelity full motion simulations. When properly constructed, simulation training works because it enables exploration and experimentation in realistic and safe scenarios, and incorporates practice, context-sensitive support and feedback, all of which are research-supported learning aids (Salas et al., 2012; Noe & Colquitt, 2002). Simulation training gives the trainee a high degree of control over the training situation. This control will only be beneficial if the trainee is guided or otherwise supplied with information on how to make effective use of this control (Bell & Kozlowski, 2002). There are several studies that point to encouraging results using simulation training, but we know little about exactly why simulators work. Simulation does not lead to learning in itself, and Salas & Cannon-Bowers (2001) calls for more systematic evaluation of large-scale simulations, where one do not rely mostly on trainee reaction data, as has been the case for many of the studies on simulation training, but rather on performance or learning data.

On the job training

Learning is not a one-time event but a continuous process that takes place in both formal and informal settings. On the job training can be a continuous learning process provided that the formal training gives the workers the necessary tools and knowledge repositories training, so that communities of practice are established where the workers can use each other as learning resources (Salas et al., 2012; Grötan et al., 2010). A strong supportive climate before and after a training program, both from peers and managers, do influence training outcome (Salas et al., 2012; Saks & Belcourt, 2006; Salas & Cannon-Bowers, 2001; Colquitt, LePine & Noe, 2000). Buddy systems and discussion sessions can be a good way of ensuring support from supervisors and peers, both before and after a training program, making it easier for the employees to use what they have learned (Salas et al., 2012; Grossman & Salas, 2011, Saks & Belcourt, 2006). With ongoing support from the leaders, on the job

training can lead to greater innovation and tacit skills (Aguinis & Kraiger, 2009). Tacit skills are usually not acquired through formal training, but through extended periods of experience where the individual develops an intuition for making sound judgments on how to perform a task (Wold & Laumann, 2015; Aguinis & Kraiger, 2009; Choo, 2001).

Training on resilience

The concept of resilience is particularly interesting for organizations operating in a high risk environment. It will always be variations in how a sociotechnical system like an offshore installation performs, and resilience is a matter of how the individuals and the organization as a whole are able to cope with these variations. Resilience is the ability to maintain a dynamically stable state in spite of adversity, to continue operations during stress, unanticipated surprises, and minor and major mishaps, and to learn and grow from these unwanted events (Sutcliffe, 2011; Grote et al., 2009; Hollnagel et al., 2006). To improve resilience one must improve the individual's skills at improvisation, learning, multitasking and adapting (Sutcliffe, 2011), and create flexible routines to achieve the right balance between standardization and flexibility (Grote et al., 2009). Extensive rules and procedures might be at the expense of flexibility, so it is important to balance the need for standardization and the need for flexibility (Sutcliffe 2011; Grote et al 2009; MacDonald 2006).

Routines and procedures are often seen as protective mechanisms against human error, but should rather be seen as a way to help people structure activities across toughly similar but subtly different circumstances (Grote et al., 2009; Dekker, 2003). Procedures are resources for action, but cannot dictate their own application or guarantee safety. Procedures must be adapted by people with sensitivity to context. The clue then is not simply telling people to comply, but to help them develop skills to know when and how to adapt and to make a professional evaluation of the situation (Wold & Laumann, 2015; Dekker 2003). Adaption of procedures in an activity requiring cognitive skills on behalf of the worker in judging when and how to adapt (Wold & Laumann, 2015). These cognitive skills can be built through mental training and simulation, practical and varied experiences, on the job training, learning from feedback and ad hoc networks that allow for rapid pooling of expertise to handle unanticipated events (Sutcliffe, 2011; Grötan et al., 2009).

Factors with effect on training outcome

The research literature is rich on examples of how an organization can make their in-house training more effective. Training is not merely about gaining new knowledge and skills, but must also have an impact on work performance.

Analysis of training needs

Before one develops training program, or changes an existing one, one should analyse the needs of the organization, the specifics of the job-tasks and the persons involved. This will provide clues as to where training is needed, existing resources and constraints, what the training priorities should be, and culture and norms in the organization that need to be considered (Salas et al, 2012; Aguinis & Kraiger, 2009; Dierdorff & Surface, 2007; Arthur et al, 2003; Salas & Cannon-Bowers, 2001). For instance, it is impossible to remember everything in the Safety Management System, so training should seek to enable the workers to find the information they need when they need it. The pre-training analysis should give an account what information workers need to learn by heart versus what they need learn how and where to access (Salas et al., 2012).

Motivation

Motivation to learn refers to an individual's "direction, intensity, and persistence of learning-directed behaviour in training contexts" (Colquitt, LePine & Noe, 2000, p. 678), and is an important factor to facilitate effective learning (Salas et al., 2012; Grossman & Salas, 2011; Salas & Cannon-Bowers, 2001; Colquitt et al., 2000). A prerequisite for motivation is that the trainees perceive the training as relevant and useful and within their capacities, and is influenced by individual characteristics, the work environment and the training itself (Salas et al., 2012; Grossman & Salas, 2011; Aguinis & Kraiger, 2009; Salas & Cannon-Bowers, 2001; Colquitt et al. 2000). Organizational and supervisory support before and during training can enhance motivation to learn, as well as positive experiences during the training itself, for instance if the workers see the training content as useful according to their job demands (Salas et al., 2012; Salas & Cannon-Bowers, 2001; Colquitt, LePine & Noe, 2000). The employee's expectations to the training can affect their learning, and these expectations can often be improved with proper communication prior to training (Salas et al, 2012; Arthur et al, 2003). Mandatory training, particularly when safety issues are involved, is also a signal that the management regards this as important (Salas et al, 2012).

Skill decay

If the employees do not get the opportunity to use the skills and knowledge they acquired during the training program, skill decay is likely to occur (Salas et al, 2012; Arthur et al, 2003). Skill decay refers to the loss or decay of trained or acquired skill. Skill decay particularly occur when employees are not required to use newly acquired skills for long periods of time, and the longer the periods of non-use, the greater the decay (Arthur et al, 2003). Cognitive tasks are more susceptible to skill decay than physical tasks, and training in these kinds of tasks should be refreshed on a regular basis (Salas et al, 2012; Arthur et al, 2003). Repetition, practice and feedback are the best ways to avoid or reduce skill decay (Arthur et al, 2003; Driskell, Copper

& Moran, 1994). A training program should be followed up by additional learning opportunities, practice and discussion for the employees, and opportunities for them to apply their new skills and abilities in their normal working conditions (Salas et al, 2012; Grossman & Salas, 2011; Saks & Belcourt, 2006; Salas & Cannon-Bowers, 2001). Choice of training method can also influence skill decay, for instance have training on cognitive skills been found to lead to better retention than conventional training, thus mental training appears to have a positive effect on reducing skill decay (Arthur et al., 1998).

A study of training on Safety Management System in two organizations

This study presents empirical data collected from employees in two different companies in the petroleum sector. The purpose is to see how the training strategy is in the two companies and how the workers perceive the Safety Management System.

Method

Subject

The data set consisted of qualitative in-depth interviews with 27 employees in two different companies in the Norwegian oil and gas production sector, hereby named Company A and Company B. Two rounds of interview were conducted in Company A. The first round of interviews was with three onshore executives who have had an active role in the development of the company's Safety Management System. The second round of interviews was with five offshore executives and 10 offshore workers, representing different disciplines; mechanics, electricians, logistics and lab technician. These were interviewed on board at the oil and gas producing installation. The interview round in Company B was conducted on land, with nine foremen and offshore installations leaders in Company B, a company that provides contract workers to an oil and gas producing company (no affiliation with Company A).

Company A

Company A have developed their own Safety Management System. The operators have their own PC in their workshop, where they can log on to the Safety Management System with their personal user. At least, this goes for those who are regular crew on the platform, whether they are employed by the petroleum company directly or are hired contractors. If they are out on deck and need a procedure or checklist, they will have to go inside to get this. Some operators might not have their own defined user account in the Safety Management System, for instance contractors visiting on short term basis, and for them the availability goes via a foreman or installation leader.

Company B

Company B don't run any offshore installations, but hire out contract workers to companies that do. Company B have developed their own management system, but when the workers are offshore for a client, it is the client's managements system that takes precedence. In the interviews we talked mainly about the situation when they are offshore using the customer's management system. When offshore, only the installation leaders and the foremen had their own PC with access to the Safety Management System, either in their office (installation leaders) or at their work station (foremen). The management system has mainly been used by foremen and

installation leaders, but there is now a development towards that also operators shall use the management system. The operators can access the Safety Management System through reduced facility computers in the coffee area, which gives them a limited access to parts of the Safety Management System. For other parts of the management system, they have to contact their foreman or installation leader.

Data collection process

The interviews were conducted in a secluded room during the normal working hour of the informants. Offshore workers in Company A were interviewed on the offshore installation. The workers in Company B were alternating between onshore and offshore work, and they were interviewed at their onshore place of work. The interviews followed a semi-structured interview guide where certain topics were planned in advance, but also allowing for the informant to bring new topics to the table, and also allowing for the structure for each interview to be different according to how the informant associated the various topics. The interview started off by letting the informants tell about their routines for an ordinary work day and to describe the Safety Management System and the purpose of it. The questions then went into more detail about which procedures they used and in which situations, how they learnt about the Safety Management System, about the user friendliness of the system, shortcomings and advantages. The duration of the interviews was 30-45 minutes, with a few exceptions. The interviews with the executives generally lasted longer than the interviews with the operators. The interviews were conducted and transcribed by the first author of this paper.

Data analysis

The data was analysed using a thematic analysis. Thematic analysis offers a theoretically-flexible approach to analyse the major themes to be found in interviews (or other qualitative data) (Howitt, 2010; Braun & Clarke, 2006; Aronson, 1994). The first step was familiarizing with the data by transcribing the audio interview tapes. The transcribed material was then fed into the software program NVIVO 10 and coded into many categories and sub-categories (nodes is the term used in NVIVO 10).

Themes related to training were prioritized in the coding. This first round of coding was rather broad. After the initial coding it became clear which categories could be developed into themes, like training, follow up and motivation, while other categories were either placed as sub-categories or were too small to qualify as themes. After re-reading the coding of each theme, some themes collapsed into each other while other themes were broken down into separate themes. The development of themes was not theory driven, but guided by the interview material.

Results and discussion

Themes

The four main themes developed was training program, follow up, skill decay and motivation for use. Sub categories are listed in table 1.

Table 1 in about here

The training program

The training for the workers is similar in both companies. It is a short web-based introductory course with a multiple choice exam at the end, and each new worker goes through it individually. It is designed to last for two hours, but most workers spend far less time on it. The executive are aware of this.

3: They must answer 10 questions at the end of the course, and then it is registered that they have completed the course. It is done in half an hour.

The workers can take the same test several times until they reach the required score of 8 out of ten points. This is a requirement to get a license to work on the offshore installation.

Practical exercises

It is difficult to learn how to use such a complex system only through theoretical exercises. All the informants in both companies said they would prefer more practical training.

10: Well..., I think it would have been better if they made some group assignments, so to speak. To present for us a specific problem we should go through. Then people would have to solve that task. Now it was more like demonstrated, with someone pushing buttons on a screen. In my experience it is better to push the buttons myself, rather than watching someone else doing it.

Informants in both companies said that they had to “fiddle about with it for a while” in order to get familiar with the Safety Management System and to be confident in using it.

23: The feedback we get [from the workers] is that they get a different perspective when they can sit calmly and go through the specific task demands for themselves, instead of just being handed a print-out.

Repetition

Related to the need for practical training is the need for repetition. Neither company had a formalized repetition of the training. One of the installation managers in company B said that he did not really learn much from the web-based training course the first time he took it, but on his own initiative he underwent the same course after his first rotation on the offshore installation. He found this to be very rewarding.

25: [The training course] did not give me anything. It was much better to be out in the field and use [the management system] for a bit, and then go through the course again. That gave me a lot more.

The informants said the only way they could really get familiar with the management system was through practical use.

18: Generally with these kinds of systems you will, or at least I benefitted more from such courses a bit later. I understand that you need a certain introduction before you can start using it, but it is also very helpful to have the course afterwards. Because that's when the questions start to pop up, when you have started to use it.

A repetition of the course after a period of practical use would probably help the workers in getting a combination of practical knowledge and theoretical understanding of the management system and the procedures.

Learning outcome

A central point in any training program is exactly what the learning outcome is supposed to be. What must the operators on the installation have to know about the management system? One of the executives had this to say about that.

3: They should know some of the background of the management system, why we have it. And they need to get an understanding of the structure, and that every object is clickable. (...) And that if they have questions, they can find more by clicking on the links in the object.

It seems that most operators, if not all, have understood the basic idea of clicking on various objects in the management system, but when it came to the background and the purpose of the system, many of them could only give vague descriptions, usually something about checklists and procedures.

11: If I can describe it, yes? No, I don't know. It is a system that tells you how, what you should do and what you shouldn't do. Isn't it?

16: There are some boxes and different columns and such that we can click through, but in the daily work I don't use it at all. I'm not very good at it, really.

It seems that the learning outcome is not quite what was desired.

Follow up

Though the training program itself is neither repeated nor otherwise followed up, there are at least some formal and informal attempts to follow up and to develop the knowledge about the management system.

Formal discussions

Both companies had a formalized system of reviewing the work processes.

4: We have a scheme, an activity scheme, which dictates that (...) everybody shall review two work processes, mainly two of the most relevant work processes, every quarter, and we report it on a list when it's done.

Generally, the executives seemed to be more aware of this than the operators.

11: I think there has been some follow up, in general meetings and such. Morning meetings, or HSE-meetings.

Some of the operators said they would like more formal discussions or meetings about the management system and the procedures.

18: I think we would have benefitted a great deal if we for instance had some safety meetings, maybe one meeting on each rotation, where we could work with some cases from the part of the management system that we use. We could do some cases and work through them together. I think that would be good.

Informal discussions

It doesn't happen often, but sometimes the management system is the topic for more informal discussion among operators at the installation, usually with a negative focus, sometimes just to blow off some steam.

10: Many people are negative about it. (...) They say it's crap (laughs). The management system, when we talk about the management system and the layout and these buttons to click yes and no, it is usually with a bit of negativity, yes.

The management system also sometimes becomes the topic for discussions when the operators run into a problem while working with a specific task, and they need help from a colleague to find what they need in the management system.

12: If you have a particular kind of task, you have a lot of colleagues around you. So you don't just stand there banging your head against the wall, you just go and ask them, if you're not quite sure about something, so you can move on.

In general, the management system is a topic for discussions only when they run into problems.

Learning by doing

According to the informants, there was no particular follow up when they were done with the training course. From then on, it was learning by doing.

13: Not much. We got an introduction right at the beginning, and that's pretty much it. The rest is a result of learning by doing.

The informants said that you have to use the management system a lot in order for it to become easy. One would think that the purpose of a training program is to enhance the competence to such a degree that a long period of learning by doing is not necessary.

14: If you use it often, if you have to use it all the time, I'll guess it will become easy eventually.

The informants said it was okay to use the management system once they got used to it, but that they needed some time to get used to it. Several of the informants criticized the poor user friendliness of the management system, but some of them nurtured a hope that it would improve.

15: To begin with it was difficult to find what I needed. You had to feel your way, and it was difficult to find the various procedures and check lists, but it got better and better. It becomes easier and easier to use, you know. When you have worked with it a bit, you know the flow, and you know where to look.

What this informant is pointing to, is a development within the user himself as a result of learning by doing, not a development in the management system.

Skill decay

Some of the informants said that the rotation system, where they are 14 days on the installation and then have 28 days off, is an obstacle with regards to learning the management system well and to get a good routine on using it.

17: The way we work, with four weeks off and then two weeks out here... when you are at home, you don't think about work. And so, things that you did half a year ago, you might have forgotten all about it. That's just human. (...) Things that you don't use on a daily basis, and you try to do remember it...

Motivation for use

Related to the motivation for learning about the management system is the workers own motivation to use the management system on a daily basis. The onshore executives demanded and expected that the workers were motivated to use the management system as part of their job as professionals and out of loyalty to the company. However, it turned out in the interviews that many of the offshore workers were not very motivated to use the management system. This lack of motivation was often linked to a general disliking towards using computers, and to a lack of understanding of the purpose of the management system, and that they did not find it very useful.

Dislike computers

The developers of the management system assume and demand a certain level of computer knowledge among the operators for them to be able to use the system as intended. But do mechanics and electricians automatically have this level of computer competence? Several of the operators did not enjoy using computers.

11: We are used to do our job without having to use computers. (...) We are perfectly able to the job without having to sit for an hour reading documents before we start. They have to explain why we should go through all these documents. (...) Why should we sit here and read for an hour when we can just go out and do the job?

This is a background factor which can have a negative effect on their motivation for spending time in at the computer, thoroughly learning how to use the management system.

Purpose

One important basic factor in using a management system and the procedures is to understand the purpose of the system and the procedures and the higher-level goals

(O'Hara et al 2000). The operators in Company A were not able to explain the purpose of the management system, and hence they didn't see the point in using it. They acknowledged that it was necessary to have a management system, but couldn't explain why.

10: Well, yeah, the management system is there, and we're supposed to use it. But when it comes to regular operations we know the old rut and how we should do the job.

The Company B informants would to a greater extent point to the basic idea of having a management system as a storing and categorizing of experience to form a knowledge foundation to evaluate the line of action for new tasks.

24: It's the best of [the company's] 40 years of experience in oil production. (...) What they have gathered there, is the best praxis. How to perform a task and how to relate to HSE and everything we're in touch with. But it is never elaborative. In the end it's still we that have to put the final piece to the puzzle, because it is a lot of good stuff in there, but it can't tell you everything. It doesn't tell you what the weather will be like that day, for example. You still have to think.

The informants in Company B stressed the importance of having clear guidelines and procedures to relate to.

19: The purpose is not to set limitations, but to lay down clear guidelines as to how a company should be run, the company's activities, to ensure the company's best interest, and the workers' best interest.

Usefulness

A recurring theme in the interviews in Company A was that the informants found it difficult to find their role in the management system, and to find the procedures that were applicable for their role in the organization

4: You get the feeling you're in a circle, and endless loop. (...) I've heard many people say the same. That they get the feeling it's a bit like, well, that you're in a loop.

Both operators and offshore executives in Company A said they had problems navigating in the management system, and that it was difficult to find the checklists and procedures they needed for the job. They said they got the feeling of going in circles, and that it felt like a never ending story. They expressed irritation that they had to skim through a lot of material they thought they didn't need in order to find the exact documents they needed.

13: There's too many processes and path in there, too many owners, and it's making it difficult to find your way through it. You have to identify the job you're going to do by choosing between several options. And you're supposed to come out again on the other side, and then the system is supposed to tell you which procedures you should use. But it is not relevant at all, because as I said, I've tried it and it doesn't work.

When unofficial action yields better and quicker ways to do the job, it also functions as a sign of competence and expertise, and being able to outsmart hierarchical control

and compensate for higher-level organizational deficiencies or ignorance (Dekker, 2003).

12: Well, I have got all the checklists for Hot Work Class B hanging on a note, so I don't have to go and find it in the management system.

This informant had simply printed out a bunch of checklists which he kept in a pile in the workshop, instead of going into the management system every time a checklist was needed- an obvious drawback with such a solution is that they would miss out on any updates or changes in the checklists. The informants themselves acknowledges this drawback, but still found it to be a more practical and useful solution.

10: Well, yeah, the management system is there, and we're supposed to use it. But when it comes to regular operations, we know the old rut and how we should do the job.

The idea that you don't really need the management system if you're competent and experienced, was widespread among the operators in Company A. In contrast, foremen and offshore installation managers in both companies saw the procedures and the management system as a collection of best practice principles guided by many years of collective industrial experience.

General discussion

Workers in both companies in this study undergo a short web based introductory course to the Safety Management System, with a multiple-choice test at the end. There is no repetition or practical exercises, other than learning by doing. Company B had a buddy system where rookies were teamed up with more experienced workers for their first period on the offshore installation. All the informants in both companies said that the management system was easier to use once they got some experience in using it, and that they had to "fiddle about" with it for a while to find out how it worked. This fiddling about takes place during their normal working day when they have specific and highly safety regulated tasks to perform. The short training course with no follow up is also a way of communicating that the management system isn't really that important.

The informants who were able to say something about the purpose of the management system had a much better use of it than those who could only give vague descriptions of the management system and the purpose of it. Foremen and offshore installation managers in both companies saw the procedures and the management system as a collection of good practice principles guided by many years of collective industrial experience, while operators were more likely to rather rely on their own experience. The results in this study resembles earlier findings that while executives perceive the Safety Management System as a fundamental tool for safe

conduct, the attitude among the workers is often that they can do their job properly without it (Wold & Laumann, 2015). This can be improved with proper training.

An important success factor for an organization in hazardous industries is the ability to make sure that the workers have solid knowledge and understanding of the rules and procedures. Training always comes with a cost, but multiple studies also shows that training improves organizational performance, and should therefore be seen as an investment in knowledge and human capital (Aguinis & Kraiger, 2009; Sitzmann, Kraiger & Kanar, 2009; Arthur et al., 2003; Salas & Cannon-Bowers, 2001). The easiest, quickest and cheapest way of improving the training immediately is to require that everyone repeats the existing training course after their first rotation on the offshore installation, but in the long run a more profound review and revision of the training program is advised. These are added up in table 2.

Table 2 in here

A training needs analysis should be conducted before one develops a new training program, or changes an existing one. The analysis should clarify which competencies the organization needs, the specifics of the job-tasks and the persons involved, and culture and norms in the organization that need to be considered (Salas et al, 2012; Aguinis & Kraiger, 2009; Dierdoff & Surface, 2007; Arthur et al, 2003; Salas & Cannon-Bowers, 2001). Then training priorities should be set up accordingly. For instance, it is impossible to remember everything in the Safety Management System, so training should seek to enable the workers to find the information they need when they need it. The pre-training analysis should make clear what information workers need to learn by heart versus what they need learn how and where to access (Salas et al., 2012). The aim of the training should not be to make the workers trust the procedures blindly, but should rather give knowledge about the purpose of the procedures, and to minimize overdependence and enable workers to cope when there are disagreements between the crew and the procedures. The clue then is not simply telling people to comply, but to help them develop skills to know when and how to adapt and to make a professional evaluation of the situation (Wold & Laumann, 2015; Dekker 2003; O'Hara, 2000).

This should be done with a combination of theoretical courses and practical exercises. The theoretical introduction can be done with classroom training or web based courses. The content of the training is more important than delivery mode, so companies should choose the most practical one. For instance can web-based courses be practical for geographically dispersed organizations. Classroom training and lectures can open up for more dialogue based learning in a supportive environment,

but can be inconvenient and costly to set up for geographically dispersed organization.

Practical exercises are required in order to familiarize with the management system. Practical training could be done with classroom training, simulations, workshops, or on the job training. On the job training can help to improve innovation and tacit skills and to establish communities of practice where the workers can use each other as learning resources (Salas et al., 2012; Aguinis & Kraiger, 2009). Simulation training on a fully developed Safety Management System ought to be rather easy to set up, either as a web based course or as workshop sessions on the work site.

Repetition will help the workers to get a combination of practical knowledge and theoretical understanding of the management system and the procedures, and will reduce skill decay. Repetition can be done by one the job training, workshop sessions, simulations and mental training. Buddy programs and on the job training will also be helpful in order to ensure some repetition, and can be supplemented with workshop sessions and discussion. Mental training cannot replace physical training, but offers a cost effective repetition, particularly for tasks that require cognitive capacities, but also for physical tasks. Relatively short mental training sessions, approximately 20 minutes, every two weeks, is enough to have a significant effect on learning outcome.

The workers' motivation can have a great impact on training outcome, and can be improved if the workers perceive the training as relevant and useful. Motivation can be increased by organizational and supervisory support before and during training. Motivation to learn is also increased when the workers perceive the training as relevant and useful, and when they have positive expectations to the training. Proper communication prior to training increases the chances that the workers understand the purpose and the importance of the training. The content of the training itself can also have an effect on motivation, especially if it helps the workers understand the purpose of the Safety Management System and why it is useful according to their job demands.

Skill decay can be reduced if the training is followed up by additional learning opportunities when the workers have acquired some experience in using the Safety Management System. On the job training, buddy systems and discussion sessions can be good ways of ensuring support from supervisors and peers, both before and after a training program, which contributes positively to the learning climate, making it easier for the employees to use what they have learned (Grossman & Salas, 2011, Saks & Belcourt, 2006; Salas et al, 2012).

Sum up and conclusion

Executives and workers relate to the management system very differently, and this affects the training and communication process (Wold & Laumann, 2015). While executives perceive the Safety Management System as a fundamental tool for safe conduct, the attitude among the workers is often that they can do their job properly without it (Wold & Laumann, 2015). The workers acknowledge the need for safety measures, but they don't see how the Safety Management System is supposed to ensure safety, and hence, tend to regard it as less important. This negatively influences their motivation for use.

The training should be constructed from a basic perspective that the Safety Management System is a communication system, not merely a tool. The training should focus on establishing an understanding of why and how the Safety Management System has been constructed in the first place, what the purpose of it is and how previous experience over many years have been accumulated here. The operators must have awareness that being good at their jobs means having knowledge about the procedures and being competent in putting them to good use. Training should help the workers to understand the limitations of the system, and to develop the skills needed to be able to evaluate when and how they should adapt the procedures to a given situation.

Training represents a cost for any company, but also an investment in human capital that will enable the workers to utilize the management system in a better, safer and more efficient way. Repetition, practice and feedback are essential elements in training.

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