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Including Knowledge Creation & Enabling in Risk Management

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Change is the law of life,

and those who look only to the past or present
are certain to miss the future

[John F. Kennedy 1917-1963, 35th President of the United States]

ABSTRACT

As a contribution to Statoil Technical Efficiency Programme (STEP), has the thesis looked at how to improve the risk management process in Statoil ASA. Through theoretical research was the primary research question created:

"How can knowledge creation & enabling improve our understanding of risk management?"

To create a theoretical foundation, the thesis looked at principles, methods, and models for the adequate assessment and management of risk. This includes a new perspective on risk that emphasizes the combination of probability-based thinking, a knowledge dimension, and surprises (black swans).

In addition, to be able to understand how knowledge could improve our understanding of risk management, different theories were studied. The theory of knowledge creation & enabling was used, as this emphasizes knowledge enabling activities to be able to create knowledge at different steps. These knowledge creation steps are; *sharing tacit knowledge, creating a concept, justifying a concept, building prototypes, and cross-leveling knowledge*. Knowledge cannot be managed, and must be enabled through; *instill a knowledge vision, manage conversations, mobilize knowledge activist, create the right context, globalize local knowledge*.

Through interviews, observations and documentation was Statoil ASA used as a case study. This was to test the hypothesis of a close connection between knowledge creation & enabling and Statoil's risk management process.

Each of the knowledge creation steps was analysed in a Statoil ASA context, which was investment project's risk identification/assessment meetings and workshops. Knowledge enablers were used to look at ways to improve their risk management.

Further, findings from the case study were discussed in a more theoretical perspective. The thesis discussed how knowledge affects the risk management process and more specifically how each of the enablers affects risk management.

The thesis concludes that there is a close connection between risk management and knowledge creation & enabling. The case study demonstrated that knowledge enablers already are a part of the risk management process. However, the organisation was not conscious of it, and a focus on it may improve their risk management process.

Through the analysis, a few improvements for Statoil ASA were suggested. These suggestions surfaced from the use of knowledge enablers, and may improve how risk is understood in the project team. It may improve the project team's knowledge to better identify and assess risks, and how knowledge of the risks are cross-leveled between investment projects.

PREFACE

This thesis, written in the spring 2015, represents the end of a master degree in Industrial Economics at the University of Stavanger. Master's thesis is a mandatory task and is equivalent to 30 credits. These two years at the masters has been exciting, educational and has given me specializations in project management, risk management and contract management.

Last summer (2014), I was lucky to be given the possibility of a summer internship as a Quality & Risk Manager at Statoil ASA. I was able to participate in project meetings in the Gina Krog project and work with their tools, constantly in search for a possible master's thesis. After discussions with project team members, experience transfer and lessons learned seemed like relevant and interesting topics these days. Suddenly, I was in a meeting with the Leading Advisor of risk management where we discussed possible subjects for the master's thesis within risk management, experience transfer and lessons learned. There were also discussions about how to improve their risk management tool, and through these discussions, a research question developed.

However, I have had difficulties creating a suitable research question and it has changes countless times over the past year. The subject chosen was difficult and a lot to comprehend. In addition is Statoil ASA a huge and complex organisation, and understanding possible ways to transfer experience across the organisation was challenging.

Fortunately, I have been surrounded by helpful people, and without them, I would have struggled with this thesis.

First, I would like to thank Hege Dybvig Andersen for wanting to be my supervisor at Statoil ASA. You have always been available to help me when I struggle, and your dedication to the subject has been an inspiration. I thank you for taking the time to read the thesis and provide with good advice and constructive feedback.

I would also like to thank everyone at Statoil who could spare some of their valuable time in their projects to be interviewed. All of the interviews have been of great contribution to the thesis. I thank Quality Leading Advisor for reading through my thesis and give valuable feedback, and all of the Quality & Risk Managers for including me as one of their own by bringing me to meetings, workshops and teambuilding exercises. It has truly been inspiring and educational.

Last, I would like to thank my supervisor at UiS, Eric Christian Brun. I thank you for taking the time to help me find theory, and providing me with good advice and constructive feedback.

Stavanger, June 2015
Eirik Hop

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LIST OF ABBREVIATIONS AND ACRONYMS

AAR	-	After Action Review
ALARP	-	As Low As Reasonably Practicable
AO	-	Asset Owner
AOR	-	Asset Owner Representative
BCLT	-	Business Case Leadership Team
CEO	-	Chief Executive Officer
COP	-	Community of Practice
CVP	-	Capital Value Process
D&W	-	TPD Drilling & Well
DG	-	Decision Gate
E-Room	-	Browser-based client application used for information exchange between company and the various contractors, as well as company-internal collaboration
FEED	-	Front End Engineering Design
HAZOP	-	Hazard & Operability Analysis
HSE	-	Health, Safety and Environment
IRIS	-	International Research Institute of Stavanger
MoK	-	Microcommunity of Knowledge
PD	-	Project Development
PDR	-	Post Deal Review
PETEC	-	Petroleum Technology
PIMS	-	Project Information Management System
PIR	-	Post Investment Review
PM	-	Project Manager
PMO	-	Program Management Office
PPA	-	Post-Project Appraisal Unit
PRO	-	TPD Projects
PSA	-	Petroleum Safety Authority Norway (Ptil)
QRM	-	Quality & Risk Manager
R&D	-	Research & Development
STEP	-	Statoil Technical Efficiency Programme
TEX	-	TPD Technology Excellence
TPD	-	Technology, Projects and Drilling (Statoil Business Area)

1 INTRODUCTION

"An organization's ability to learn, and translate that learning into action rapidly, is the ultimate competitive advantage."

[Jack Welch]

PSA (Petroleum Safety Authority Norway) has often stated the last years that Statoil ASA (hereby known as Statoil) does not learn from their mistakes. This statement was supported by a report from IRIS in 2011 describing the underlying causes from the incident on Gullfaks C. Some of the suggestions made in the report were improved processes and tools for cross-project learning and sharing of knowledge (IRIS, 2011).

Learning from mistakes has been on the Statoil agenda for a while. However, high oil prices and many ongoing projects have made it hard to focus on the implementation of new processes. At project end, people run to the next project, not having the time to sum up experiences from their previous project.

Today, low oil prices have forced the oil & gas businesses to cut costs, as less projects are profitable and therefore stopped or put on hold. Less ongoing projects gives more time and focus on improvement of internal processes. Statoil wishes to utilize this period to cut their costs to a minimum, and improve their internal processes, making them ready for the future.

STEP (Statoil Technical Efficiency Programme) was introduced in 2014, and is an efficiency programme created to ensure Statoil's profitability and competitiveness in the years ahead. It aims to maintain Statoil's technological advantages, while increasing the efficiency, which is a part of ensuring that Statoil can create and sustain long-term value. STEP aims to realising an annual improvement of Statoil's bottom line by USD 1.7 billion from 2016. Improving the bottom line gives Statoil a more robust future, more projects will become profitable, and Statoil can extend the lifetime of more fields.

The Quality & Risk Management function in Statoil will contribute to STEP through their own improvement agenda. It is done by strengthening the Quality & Risk Managers role, reinforcing project front end loading, enhancing risk based supplier follow up and accelerating organizational learning.

The Quality & Risk Manager's role will be strengthened by a focus on developing the role to better meet project needs and increasing the flexibility of the Quality & Risk Management Organization.

To accelerate organizational learning, the focus of Statoil is to find a link between the risk management process and experience transfer. In addition, the experience transfer processes and experience transfer tools are to be improved and the risk register is to be evaluated as a source of information for cross-project learning.

The goal is to be able to identify risks earlier, and be better at implementing risk-reducing measures by learning from other projects. This leads to the following research question, which will be the starting point of Quality & Risk Managements contribution to the STEP program.

1.1 RESEARCH QUESTION

The thesis has two type of research questions, primary and secondary. The primary research question is:

"How can knowledge creation & enabling improve our understanding of risk management?"

By using Statoil as a case study, the thesis will look at how knowledge creation & enabling could improve our understanding of risk management. This focus leads us to the secondary research questions the thesis will answer.

- What is knowledge and how will strong knowledge affect the risk management process at Statoil?
- How does one gain strong knowledge in a risk context?
- What suggestions of knowledge creation & enabling activities could be put in place at Statoil to better identify, assess and manage risk?
- How will it affect the role of the Quality & Risk Manager?

1.2 LIMITATIONS

In the theory later on, the knowledge creation process includes all of the organization to work properly. The perspective of this thesis should look at the organization as a whole, but because of limitations, this thesis will only focus on a very small part of the organization. This part is risk management in investment projects, and therefore you will notice that the enabler instill a knowledge vision is neglected from the analysis.

Knowledge is a vast subject affected by technical, organisational, personal and psychological aspects. The thesis focuses on creating knowledge within the risk management process used by Statoil in investment projects. In addition, on how the Quality and Risk Manager (QRM) shares the knowledge created across projects. Further, their risk register is the starting point for creating and sharing knowledge. The process will focus on the risk register as an example of how knowledge can be enabled, created and shared.

2 THEORETICAL FOUNDATION

The first part of this chapter will focus on relevant risk management theories. Afterwards, knowledge terms will be presented before suggesting different knowledge enabling theories for knowledge creation.

2.1 RISK MANAGEMENT

Aven (2008) uses the definition of *risk management* as all measures and activities carried out to manage risk. Risk management deals with balancing the conflicts inherent in exploring opportunities on the one hand and avoiding losses, accidents and disasters on the other.

Risk management relates to all activities, conditions, and events that can affect the organisation, and its ability to reach the organisation's goals and vision. In many enterprises, the risk management task is divided into three main categories, which are management of:

- Strategic risk, includes mergers, acquisition, technology, competition, etc.
- Financial risk, includes market risk, credit risk, liquidity risk, etc.
- Operational risk, includes accidental events, intended acts, loss of competence, etc.

Risk management often involves decision-making in situations characterised by high risk and large uncertainties, and such decision-making presents a challenge in that it is difficult to predict the consequences (outcomes) of the decisions. Various *decision-making strategies* can form the basis for the decision. By "decision-making strategy", Aven (2008) means the underlying thinking and the principles that are to be followed when making decision, and how the process prior to the decision should be. A decision-making strategy takes into consideration the effect on risk and the uncertainty dimensions that cannot be captured by the analysis. The result is thus decisions founded in both calculated risk and applications of the *cautionary principle* and *precautionary principle*. The cautionary principle means that caution, for example by not starting an activity or by implementing measures to reduce risks and uncertainties, shall be the overriding principle when there is uncertainty linked to the consequences. While, the precautionary principle is the ethical principle that if the consequences of an action, especially the use of technology, are subject to scientific uncertainty, the it is better not to carry out the action rather than risk the uncertain, but possibly very negative, consequences.

(Aven, 2008)

2.1.1 Risk Analysis

The risk analysis shall identify the relevant initiating events and develop the causal and consequence picture. This provides a basis for decision-making. How this is done depends on which method is used and how the results are to be used. However, the intent is always the same: to describe risk. There is three main categories of risk analysis methods: simplified risk analysis, standard risk analysis and model-based risk analysis.

Simplified risk analysis is an informal procedure that establishes the risk picture using brainstorming sessions and group discussions. The risk might be presented on a coarse scale, e.g. low, moderate or large, making no use of formalised risk analysis methods.

Standard risk analysis is a more formalised procedure in which recognised risk analysis methods are used, such as HAZOP and coarse risk analysis, to name a few. Risk matrices are often used to present the results.

Model-based risk analysis makes use of techniques such as event tree analysis and fault tree analysis to calculate risk.

Risk analysis can be carried out at various phases in the life time of a system, i.e. form the early concept phase, through the more detailed planning phases and the construction phase, up to the operation and decommissioning phases. Aven (2008) believes it is easier by far to make changes "on paper" in planning phases than to make changes to existing systems in the operation phases. Therefore, risk analysis has had their greatest application in the planning phases. The risk analysis process is a central part of risk management. Aven (2008) use the term "risk analysis process," when he talks about three main phases: planning, risk assessment and risk treatment, while he use "risk management process" when other management elements are also included. Figure 1 shows the main steps of the risk analysis process.

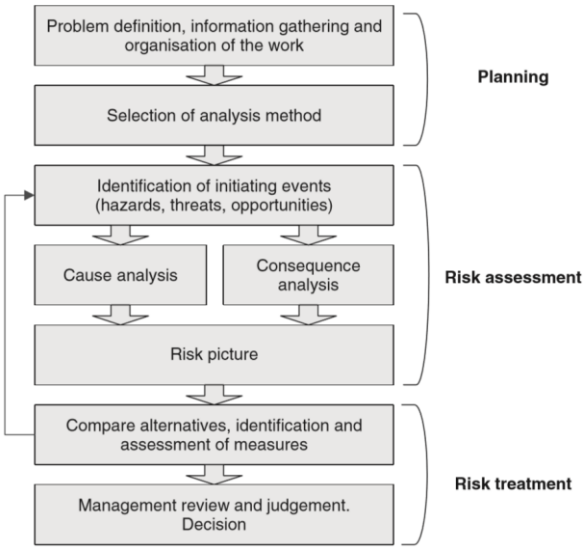

Figure 1: Risk analysis process (Aven, 2008)

A good way of looking at the risk analysis is by the use of the ALARP principle. *ALARP process* is that the risk should be reduced to a level that is As Low As Reasonably Practicable. This principle means that the benefits of a measure should be assessed in relation to the disadvantages or costs of the measure. The ALARP principle is based on "reversed burden of proof", which means that an identified measure should be implemented unless it cannot be documented that there is an unreasonable disparity ("gross disproportion") between costs/disadvantages and benefits. There are two different approaches to risk analysis. These are forward approach, and backward approach.

In the *forward approach*, the risk analysis begins with the identification of the initiating events. Thereafter, the consequences of the various events are analysed. The aim for the analysis is to identify all relevant events and associated scenarios. This approach implies more mechanised and time-consuming calculation processes. The risk description may in this case be more complete.

While, in the *backward approach*, the risk analysis begins with the identification of the resulting events, or situations that are identifies as important in the analysis. This approach is less resource intensive in terms of time, but at the same time, it requires considerable experience and competence, in order for the analysis to provide a good basis for decision-making. (Aven, 2008)

2.1.2 What is Risk?

The objective of a risk analysis is to describe risk. To understand what it means, we must know what risk is and how risk is expressed. The following is Aven & Krohn (2014) description of risk.

Risk is (C,U), where C is the future consequences of the activity considered, and U expresses that C is unknown. We often write (A,C,U) to explicitly incorporate hazard/threats A. Here C is often seen in relation to some reference values (planned values, objectives, etc.), and focus is normally on negative, undesirable consequences.

While, a *risk description* is (C',Q,K). Risk is described by specifying the events/consequences (C') and using a measure (Q) (Interpreted in a wide sense) of uncertainty, leading to a risk description (C',Q,K), where K is the background knowledge that C' and Q are based on. The most common method for measuring the uncertainties U is probability P, but other tools also exist, including imprecise (interval) probability and representations based on the theories of evidence (belief functions) and possibility. One way of representing (C',Q,K) is to describe events A', probabilities of A', i.e. P(A'), expected values of C' given the occurrence of A', i.e. E[C'|A], a 90% prediction interval of C' given A', and a measure of strength of knowledge K.

Further, we can look at *vulnerability* given A as (C,U|A), and vulnerability description as (C',Q,K|A'), i.e. vulnerability is risk conditional on A. A system is considered vulnerable, if its vulnerability is considered large, for example if there is a rather high probability that the system collapses in the case of exposure of a rather minor load. Robustness is the antonym of vulnerability.

While, *resilience* is (C,U| any A, including new types of A) and resilience description is (C',Q,K| any A, including new types of A). Hence, the resilience is considered high if a person has a low probability of dying due to any type of virus attack, also including new types of viruses. We say that the system is resilient if the resilience is considered high. (Aven & Krohn, 2014)

2.1.3 What is Probability?

Aven & Krohn (2014) believe a *probability model* reflects aleatory uncertainties, i.e. variation in infinite large populations of similar units. A probability model is a set of frequentist probabilities.

A *frequentist probability* $P_f(A)$ of an event A expresses the fraction of times the event A occurs when considering an infinite population of similar situation or scenarios to the one analysed. In general $P_f(A)$ is unknown and has to be estimated. Hence we got a distinction between the underlying $P_f(A)$ and its estimate $P_f(A)^*$

Hence, a *knowledge-based probability* P expresses the degree of belief of the assessor and is understood with reference to the urn standard. The probability P(A) = 0,1 means that the assessor compares his or her uncertainty (degree of belief) about the occurrence of the event A with the standard of drawing at random a specific ball from an urn that contains 10 balls. (Aven & Krohn, 2014)

2.1.4 A Perspective on Risk

Aven (2013) thinks expected consequences (loss) is not adequate as a general definition of risk, as two probability distributions may have the same expected numbers, one with mass centred around its expectation, the other having high probabilities for severe outcomes, and hence the risk management should be different. The concept of risk however, the same and this makes it unusable.

Authors have argued that we need a broader risk perspective, which are not linked to one specific measure of uncertainty, namely probability. The concept of risk should allow for different ways of describing the uncertainties. The new risk perspective, in addition to risk descriptions based on probability, require additional characterisation that can provide further insight about knowledge and lack of knowledge, as well as potential surprises/black swans. The (lack of) knowledge dimension captures for example that probability, used as a measure of uncertainty or degree of belief, is not able to reflect the strength of the knowledge that the probabilities are based on. The assumptions that the

probabilistic analysis is built on could conceal important aspects of uncertainty. The surprise part relates to the fact that surprises may occur relative to the knowledge of the analysts or experts conducting the assessment. Figure 2 shows the risk perspectives. (Aven, 2013)

Figure 2: Basic features of the new risk perspective (Aven, 2013)

Knowledge dimension

In most situations, we need to base the assessment on some knowledge (assumptions) to produce probabilities. We may choose to base the analysis on historical data, but this is not always representative for the future and therefore questionable. The different situations will produce consequences of different severity. The natural way to cope with this problem is to develop an uncertainty interval for the unknown consequences of the event. However, also an uncertainty interval and a distribution have to be seen in relation to the assumptions made. The uncertainty interval and distribution clearly reflect variation, but judgements based on the analysts' knowledge are also a part of the basis for the established interval and distribution.

The uncertainty interval produced, in example [0, 100], does not express the strength of knowledge that supports it. Information about this strength would inform the decision makers and other stakeholders that are to use the results of the risk assessment. The analysis could have been carried out quickly and based on poor knowledge. The question is then how we should inform the decision maker and communicate regarding this strength. What does it mean that the knowledge is strong or poor?

Aven (2013) thinks strong knowledge means small or low degree of uncertainty, and poor knowledge means large or high degree of uncertainty, but he asks to be careful when referring to the uncertainty term here as it is not obvious what we are uncertain about. The concept of "strength of knowledge" is considered more precise in reflecting the ideas that we would like to reflect. We will further look at one of Aven (2013)'s methods for assessing the strength of knowledge.

The approach is based on a crude direct grading of the strength of knowledge. The knowledge is weak if one or more of these conditions are true:

a) The assumptions made represent strong simplifications.
b) Data are not available, or are unreliable.
c) There is lack of agreement/consensus among experts.
d) The phenomena involved are not well understood; models are non-existent or known/believed to give poor predictions.

If on the other hand all the following conditions are met, the knowledge is considered strong:

a) The assumptions made are seen as very reasonable.
b) Much reliable data are available.
c) There is a broad agreement/consensus among experts.
d) The phenomena involved are well understood; the models used are known to give predictions with the required accuracy.

Cases in between are classified as having medium strength of knowledge.

Aven, (2013) suggests the following procedure for decision-making:

1. If risk is found acceptable according to probability with large margins, the risk is judged as acceptable unless the strength of knowledge is weak (in this case the probability based approach should not be given much weight).
2. If risk is found acceptable according to probability, and the strength of knowledge is strong, the risk is judged as acceptable.
3. If risk is found acceptable according to probability with moderate or small margins, and the strength of knowledge is not strong, the risk is judged as unacceptable and measures are required to reduce risk.
4. If risk is found unacceptable according to probability, the risk is judged as unacceptable and measures are required to reduce risk.

(Aven, 2013)

Surprises (black swans)

The third component of the extended risk perspective is surprises relative to the knowledge (black swans). Aven (2013) groups surprises into two categories:

I. Unknown unknowns in the strict sense, meaning that these events are not known to the scientific community.
II. Surprises compared to the produced risk picture, i.e. surprises compared to the beliefs of the experts and analysts involved in the risk assessment.

Both categories can be referred to as black swans, but the unknown unknowns in the strict sense, is difficult to include in any analysis. Aven (2013) recommends a procedure for assessing black swans in the category II.

Firstly, a list of all types of risk events having a low risk by reference to the three dimensions, assigned probability, consequences, and strength of knowledge, is produced.

Secondly, a review of all possible arguments and evidence for the occurrence of these events is provided, for example by pointing to historical events and experts' judgements not in line with common beliefs and obtain creative processes.

This list of black swan type of events of category II, with associated risk descriptions and this type of argument and evidence is reported along with the risk events having the highest risk scores according to assigned probability, consequences, and strength of knowledge. (Aven, 2013)

2.1.5 A New Way of Thinking of Risk

The assessments of risk may completely ignore a risk event or make a judgement on the basis of assumptions/beliefs that it is so unlikely that we can judge it as negligible. In both these cases we may consider it as unforeseen and as coming as a surprise. To assess and manage such events, Aven & Krohn (2014) believe that we need to see beyond probabilities and adopt a broader risk perspective. We therefore need concepts that are suitable for this purpose, which leads to four basic pillars of the new risk perspective.

1. Proper concepts (a conceptual framework), to be able to have a language for the adequate understanding of performance and risk, and related terms such as uncertainties, knowledge, surprises, etc.

2. Principles, methods, models, etc. for the adequate assessment and management (including communication) of risk, i.e. basically that deviations may occur relative to some desired or planned levels.
3. Principles, methods, models, etc. for the adequate assessment and management (including communication) of quality, with an emphasis on how to improve performance (for example production safety). In addition, the quality discourse emphasises the plan-do-study-act management method used in the business for the control of continuous improvement of processes and products.
4. The concept of (collective) mindfulness can be used as an effective instrument for managing risks, the unforeseen and potential surprises. Mindfulness is about awareness and ability to discern the details: what the essential warnings and signals are and how to adjust and be prepared when needed. It has five characteristics:
    I. Preoccupation with failure: to learn from failures and be sensitive to signals of failure.
    II. Reluctance to simplify: not base judgements of risk on pure probability-based descriptions or other narrow representations, or relies on simple rules of thumb in managing risk.
    III. Sensitive to operations: to be able to sense what is happening and take necessary actions.
    IV. Commitment to resilience: makes arrangements to be prepared for the unforeseen and surprising events.
    V. Deference to expertise: let people with the right expertise make the judgements and decisions when time and situations require so, independent of formal authority.

According to Aven & Krohn (2014), the new way of thinking about risk are focusing on the risk sources: the signals and warnings, the failures and deviations, uncertainties, probabilities, knowledge and surprises, and the concept of mindfulness help us see these attributes and take adequate actions. It means an increased acknowledgment and incorporation of principles that give weight to uncertainties, for example the cautionary principle, the precautionary principle, robustness, resilience, etc. compared to approaches based on more mechanical procedures, such as expected utility theory, and probability founded risk acceptance criteria. All these principles acknowledge that, in many cases in real life, risk cannot be measured in an objective way and that the risk management needs to reflect this, giving sufficient weight to solutions, arrangements, and measures that provide protection and consequence reductions when undesirable events, the unforeseen and black swan events occur.

Considering the future, we do not know what events will occur and what the outcomes will be; there are uncertainties; there are risks. A number of measures are introduced to avoid the occurrence of such situations and events and reduce the consequences if they should in fact happen. Risk assessments are carried out to identify key contributors to risk and support the risk decision making on which measures to implement. Risk is described for example by capturing the following elements: identifies events and consequences, assigned probabilities, uncertainty intervals, strength of knowledge judgements, as well as considerations about surprises (black swans). (Aven & Krohn, 2014)

As the knowledge dimension seems to have a key role in risk management, the next part will focus on relevant theories of what knowledge is and how to create a strong knowledge.

2.2 KNOWLEDGE TERMS

Knowledge has an unpredictable character. It is fluid, dynamic, partly tacit, partly explicit, scalable, tied to individuals as well as groups, prone to serendipitous twists and setbacks. Any attempt to control knowledge creation will end up referring to the explicit historical knowledge that already exists. This kind of knowledge rarely sparks the innovations and enabling context required to develop the future advantages of a company. (Von Krogh, et al., 2000)

This thesis adopts Nonaka's (1994) definition of *knowledge* as "justified true belief". We consider knowledge as a personal "belief," and emphasize the importance of the "justification" of knowledge. We therefore sees knowledge as a dynamic human process of justifying personal belief as part of an aspiration for the "truth." (Nonaka, 1994)

Von Krogh, et al. (2000) also writes of knowledge as justified by true belief. An individual justifies the truthfulness of his or her beliefs based on observations of the world, they state. The observations, in turn, depend on a unique viewpoint, personal sensibility, and individual experience. It can involve feelings and belief systems of which one may not even be conscious. (Von Krogh, et al., 2000)

There is a clear distinction between information and knowledge. According to Machlup (1983), information is a flow of messages or meanings, which might add to, restructure or change knowledge. Dretske (1981) offers some useful definitions. In short, information is a flow of messages, while knowledge is created and organized by the very flow of information, anchored on the commitment and beliefs of its holder. This understanding emphasizes an essential aspect of knowledge that relates to human action. Commitment is pointed out as one of the most important components for promoting the formation of new knowledge within an organization. Three factors induce individual commitment. *Intention* is concerned with how individuals form their approach to the world and try to make sense of their environment. *Autonomy* gives individuals freedom to absorb knowledge, which may increase the possibility of introducing unexpected opportunities of the type that are sometimes associated with the "garbage can" metaphor. Last, *fluctuation* that can be ambiguity, redundancy, noise, or randomness generated from the organization and its environment. Fluctuation differs from complete disorder, and help individuals recreate their own systems of knowledge to take account for these factors. (Nonaka, 1994)

2.2.1 Four Knowledge Problems

Similar to fluctuation, Zack (2001) presents four knowledge-processing challenges, which are complexity, uncertainty, ambiguity and equivocality. The relationship among the four problems is described in Figure 3.

Complexity is described by too many situational elements and relationships to coordinate or consider simultaneously, and suggests to simplify. The response to complexity is either to increase a firm's capacity to process it or to reduce the level of complexity faced by the firm. In the absence of sufficient knowledge, complexity can be reduced by decomposition. (Zack, 2001)

Uncertainty is described by insufficient factual information about the goal, situation or task, and some lack of confidence in the consequent interferences, estimates or predictions required. Uncertainty can be managed by reducing it or increasing the organisation's ability to tolerate it. To manage uncertainty, then, organizations must develop their resources and capabilities to predict, infer, estimate and learn. (Zack, 2001)

Ambiguity is described as inadequate knowledge (patterns/concepts) about, no explanation for, or understanding of a goal, situation or task. The suggestion is to clarify by providing for rich, interactive, face-to-face conversations in the organisation. (Zack, 2001)

Equivocality is described as multiple interpretations of a goal, situation or task. The suggestion is to unify. Equivocality requires either cycles of interpretation, interactive discussion and negotiation to converge on one meaning. (Zack, 2001)

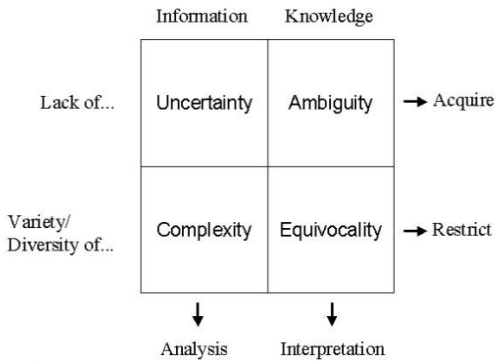

Figure 3: The Four Knowledge Problems (Zack, 2001)

2.2.2 Explicit and Tacit Knowledge

Explicit knowledge is codified knowledge and is knowledge that is transmittable in formal, systematic language. It is discrete or "digital", captured in records of the past such as libraries, archives, and databases. (Nonaka, 1994)

On the other hand, *tacit knowledge* has a personal quality, which makes it hard to formalize and communicate. Tacit knowledge is deeply rooted in action, commitment, and involvement in a specific context. Tacit knowledge involves both cognitive and technical elements. The cognitive elements center on what Johnson-Laird (1983) called "mental models" in which human beings form working models of the world by creating and manipulating analogies in their minds. These working models include schemata, paradigms, beliefs, and viewpoints that provide "perspectives" that help individuals to perceive and define their world. By contrast, the technical element of tacit knowledge covers concrete know-how, crafts, and skills that apply to specific contexts. (Nonaka, 1994)

2.2.3 Project Learning

Schindler & Eppler (2003) think that due to projects special nature as a secondary type of organisational form (e.g. limited time and resources, pressure, great complexity, new teams), projects are especially suitable for learning. They believe systematic retention of project experiences enables a company to compare its various projects more systematically and document its most effective problem solving mechanisms. In addition, the systematic documentation of mishaps, mistakes or potential pitfalls helps reduce project risks. The end of a project is consequently the end of collective learning. The involved staff moves on to new projects or they are reintegrated into their line function. If their specific knowledge of that project is not directly needed, organizational amnesia begins. In addition, external partners or consultants, who have provided crucial project inputs, leave the company after the completion of a project. The risk of a knowledge loss at a project's end is a serious problem for organisations according to Schindler & Eppler (2003). (Schindler & Eppler, 2003)

Schindler & Eppler (2003) defines the term lessons learned as key project experiences, which have a certain general business relevance for future projects. They have been validated by a project team and represent a consensus on a key insight that should be considered in future projects. (Schindler & Eppler, 2003)

Kotnour (2000) talks of learning as the process by which knowledge is created from experience and the path by which improvement takes place. Further, he use the definition that a lesson learned is "a catchcall phrase describing what has been learned from experience" and is a tool for learning. A lesson

learned overcomes the barriers to organizational learning and knowledge sharing by playing two roles. First, the process of developing a lesson learned provides an opportunity for the project team to gain full understanding of project results. Second, a lessons learned is a mechanism to document the learning to share with others. (Kotnour, 2000)

2.2.4 Knowledge Creation

Von Krogh, et al. (2000) define the term *management* as "control of processes that may be inherently uncontrollable or, at the least, stifled by heavy-handed direction". They believe managers need to support knowledge creation rather than control it. This is called *knowledge enabling*, which is the overall set of organisational activities that positively affect *knowledge creation*. *Knowledge enabling* includes facilitating relationships and conversations as well as sharing local knowledge across an organisation or beyond geographic and cultural borders. At a deeper level, they believe it relies on a new sense of emotional knowledge and care in the organisation, one that highlights how people treat each other and encourages creativity – even playfulness. There are identified five *knowledge enablers*, which is:

1. Instill a knowledge vision
2. Manage conversations
3. Mobilize knowledge activists
4. Create the right context
5. Globalize local knowledge

Von Krogh, et al. (2000) states: "Recognizing the value of tacit knowledge and figuring out how to use it is the key challenge in a knowledge-creating company, one that requires extended conversations and good personal relationships-that is, knowledge enabling."

Organisational *knowledge creation* involves five main steps.

1. *Sharing tacit knowledge* of a given product area.
2. *Create concepts* by use of the tacit knowledge that leads to a concept like specification of a functionality, an algorithm, a manufacturing process description, drawings, and so on.
3. *Justifying concepts* using information and tools to build arguments for or against concepts.
4. *Building a prototype* or something else that is not a physical representation based on the earlier steps. The general goal is to create a tangible manifestation of the team's knowledge
5. *Cross-leveling knowledge* is sharing the knowledge throughout the company, which is the team's responsibility.

Tacit knowledge requires individuals to share their personal beliefs about a situation with other team members. At that point, justification becomes public. Each individual is faced with the tremendous challenge of justifying his or her beliefs in front of others. This need for justification, explanation, persuasion, and human connectedness makes knowledge creation a highly fragile process. Therefore, this knowledge must be enabled, and Von Krogh, et al. (2000) believe that the five knowledge enablers are the best way of doing it. (Von Krogh, et al., 2000)

2.2.5 Communities

Von Krogh, et al., (2000) talks of the importance of *microcommunities of knowledge*, as these are small groups within an organization whose members share what they know as well as common values and goals. The success of the knowledge creation depends on how these and other members relate through the different steps of the knowledge enabling process. The idea of microcommunity is characterized by face-to-face interaction, and in creating knowledge, the participants also gradually get to know more about each other. The social knowledge they gain through this experience is the key

to knowledge creation and to creating the right enabling context. The communities are not limited by group, department, and division boundaries, but may overlap within and across them. (Von Krogh, et al., 2000)

On the other hand, Julian (2008) talks of *communities of practice*. Here, knowledge is constructed as individuals share ideas through collaborative mechanisms such as narration and join work. They are in the best position to codify knowledge, because they can combine its tacit and explicit aspects. Julian (2008) uses a definition that communities of practice is groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis. Further, *cross-functional project teams* can be viewed as consisting of members who may themselves belong to various communities of practice and can develop into a community of practice of time. (Julian, 2008)

2.3 KNOWLEDGE ENABLING

Table 1: Knowledge Enabling: The 5x5 Grid (Von Krogh, et al., 2000)

KNOWLEDGE ENABLERS	Sharing Tacit Knowledge	Creating a Concept	Justifying a Concept	Building a Prototype	Cross-leveling Knowledge
Instill a Vision		√	√√	√	√√
Manage Conversations	√√	√√	√√	√√	√√
Mobilize Activists		√	√	√	√√
Create the Right Context	√	√	√√	√	√√
Globalize Local Knowledge					√√

Table 1 illustrates how each of knowledge enablers influences the knowledge creation steps. It will be described further in this section.

2.3.1 Enabler 1: Instill a Knowledge Vision

Instill a knowledge vision is one of the key enabling conditions for knowledge creation. When one instill an effective knowledge vision, it help encourage the formation of microcommunities, concept justification, and cross-leveling of knowledge throughout their organisations. It can also enable concept creation and prototype building, but has less impact on the sharing of tacit knowledge within a microcommunity. However, it relies ultimately on unleashing tacit knowledge to drive innovation. More important, it will emphasize knowledge creation as an activity, putting it on top management's agenda.

A knowledge vision is firmly connected to an advancement strategy, one that emphasizes company's future performance and success based on current conditions. The knowledge vision should provide a mental map of the world organisational members live in. This is to motivate organisational members to think of their activities as part of a larger picture. Further, the knowledge vision must include a mental map of the world organisational members ought to live in. This part of the vision should motivate organizational members to trust in the future of the company. The knowledge vision should specify what knowledge the organizational members needed to seek and create. This domain indicates how to move from the present to the future. It offers a road map, and might identify streams of knowledge that have to be developed in order to reach the future state. The company's knowledge

vision may take the form of a mission statement, a set of corporate values, a document about management philosophy, or a plan that looks more like a strategic outline. (Von Krogh, et al., 2000)

2.3.2 Enabler 2: Manage Conversations

Good conversations are the cradle of social knowledge in any organisations. Each participant can explore new ideas and reflect on other people's viewpoints. The mutual exchange of ideas, viewpoints, and beliefs that conversations entail allows for the first and most essential step of knowledge creation. That is, sharing tacit knowledge within a microcommunity with an atmosphere of high trust. It is important as it affects all of the five knowledge creation steps.

"Knowledge written and stored in computers is effective only about 20 percent of the time: You can either read the operating instructions of your new video recorder for one hour, or talk to a colleague for five minutes to find out how it works." Quote Andy Rihs (CEO Phonak). (Von Krogh, et al., 2000)

This leads to four principles for managing conversations. The first principle is to actively encourage participation. The first task of the conversation manager is to establish entry points for every team member involved. Managers can set up at least two entry points into a conversation: (1) they can encourage participation by making knowledge-creating purpose clear; and (2) they can make sure entry rituals are fair and relatively easy to understand.

The second principle is to establish a conversational etiquette, as the knowledge-creating conversation depends not only on what is being said, but also on how it is said. A philosopher of language named Paul Grice (1975) suggests several maxims for conversational etiquette: *Avoid unnecessary ambiguity, avoid intimidation, avoid exercising authority, avoid premature closure* (push for conclusion)*, be brief, be orderly, help other participants to be brave,* and *do not knowingly make false statements*.

The third principle is to edit conversations appropriately. As the tacit knowledge of individual participants is embodied in their own physical experiences and emotions, selecting specific themes for discussion can be difficult. The different concepts that appear through knowledge-creating conversations should be edited down to the ones with most potential that will become the groups focus. This usually happens in two ways, through *agreement* and/or *understanding.* Agreement can easily be forced, but understanding is not achieved until all participants in a group truly feel that the expression or concept corresponds with what they know tacitly.

The fourth principle is to foster an innovative language. Marlena Fiol (1991), states that a company's language represents one of its most important assets. Language is a medium for the expressions of people's observations about the world, and their observations are required to create new knowledge. The conversation participants should in order to generate innovative concepts, speak freely and honestly, they should also allow words they use to be playful, vivid, silly, and not always "correct". This could help give new meaning to well-known concepts and terms. It will also inspire new terms that incorporate existing meanings, or new terms with entirely new meanings. People who have an ability for wordplay are often articulate, charismatic, or witty, and often energize everyone around them. (Von Krogh, et al., 2000)

The Conversation Manager

Von Krogh, et al. (2000) writes that conversations can and should be managed, either by everyone involved, or by a conversation manager who can moderate disputes, establish the right etiquette, and appropriately edit ideas. The manager should attempt to understand the influence of any kind of intervention on the trajectory of a given conversation. The participants should not be intimidated by negative attitude towards their ideas. Instead, the manager should inspire individual participants to be brave. Conversation managers are by definition caring experts, because caring relationships are

essential to talking freely, accepting constructive criticism with grace, and sharing one's personal beliefs with others. The guiding principles of managing a conversation depend on the purpose of the conversation. Conversations that help people share tacit knowledge generally involve active participation, few incisions and creative language games. The etiquette is welcoming, and encourages open and unstructured contributions. Managers have to be quite adept at adapting to the different phases of knowledge creation. Table 2 show us how the manager should adept to the different situations. (Von Krogh, et al., 2000)

Table 2: Conversational Guiding Principles for Knowledge Creation Steps (Von Krogh, et al., 2000)

	Sharing Tacit Knowledge	Creating a Concept	Justifying a Concept	Building a Prototype	Cross-Leveling Knowledge
Active Participation	• Select participants • Create awareness for knowledge-creating conversations • Establish rituals and rules • Make sure everyone contributes	• Develop rituals further • Keep participation constant	• Allow new participants into conversation • Identify groups with vested interest in the concept • Explain rituals of entry • Discuss usefulness of concept	• Review rituals of entry and make changes when needed • Disallow new participants	• Allow new participants into conversation • Make the rituals of entry democratic • Create high organizational awareness for the innovation • Review the progress of rituals and awareness in the whole process
Conversational Etiquette	• Allow for metaphors, analogies • Avoid pushing for closure • Allow for lengthy statements • Allow for chaos • "Check authority at the door"	• Give participants courage • Avoid pushing for closure • Allow for metaphors and a search for meaning • Avoid intimidation	• Consider an array of different viewpoints • Be brief and orderly • Take an examining attitude	• Allow authoritative statements from those with expertise • Do not allow ambiguous expression • Be orderly • Push for closure	• Make knowledge creation the basis for recognition of expertise • Communicate as clearly as possible • Explain the process of knowledge creation that the microcommunity went through
Editorial Judgment	• Avoid incisions • Increase quantity of concepts • Start new concept life cycles	• Base incisions on quantity and quality • Reduce the number of concepts to two or three • Delete outdated concepts	• Use justification to decide on the quality of a concept	• Use technical requirements to decide on a prototype's quality • Focus conversations through the deliberate use of language • Make cuts where needed to speed up prototype development	• Package the knowledge and describe the process in terms easily understood throughout the organization • Make incisions where knowledge developed does not apply to local environment
Innovative Language	• Experiment with new concepts and meanings • Be playful • Practice temporal and spatial scaling	• Experiment with concepts and meaning • Practice temporal and spatial scaling	• Keep concept constant; change meaning depending on feedback of participants • Practice temporal and spatial scaling, depending on justification criteria	• Keep concept constant • Reach agreement about and shared understanding of concept • Use one scale only	• Keep prototype constant • Maintain agreement and shared understanding • Use one scale only

2.3.3 Enabler 3: Mobilize Knowledge Activist

Von Krogh, et al. (2000) believe that enabling new knowledge depends on the energy and sustained commitment an organization puts into knowledge creation. That is why the third enabler, *mobilize knowledge activists*, matters so much to the process. The *knowledge activist* is a major player in at least four of the *knowledge creation* steps. They often form microcommunities of knowledge, and they smooth the way for creating and justifying concepts, as well as for building prototype. Activists are also essential for cross-leveling of knowledge, since they are the people responsible for energizing and connecting knowledge creation efforts throughout a company. Knowledge activists help establish the right enabling context that is the essential space and relationships that allow tacit knowledge to be unleashed.

They define a *knowledge activist* as a manager with broad social and intellectual vision as well as experience in nitty-gritty business operations, someone who connects external and internal knowledge initiatives and mobilizes workers throughout the organisation to use knowledge more effectively. It is important to know that knowledge activism is about enabling not controlling knowledge.

A knowledge activist may have three possible roles, the *catalyst* of knowledge creation, *coordinators* of knowledge creation initiatives, *merchants* of foresight, or all three. (Von Krogh, et al., 2000)

Catalyst of knowledge creation

A *catalyst* is an activist that travels the organisation, and is exposed to a variety of new data, ideas, insights, opportunities, questions and problems. They can pick up these signals and gradually formulate the necessary "process triggers". Process triggers might come in questions like *where, when,*

why, how, and what. This is further used to help create an enabling context for knowledge creation to use the participant's personal experience. (Von Krogh, et al., 2000)

Coordinators of Knowledge-Creation Initiatives

Coordinators of knowledge-creation initiatives are essential in almost any company. For the knowledge-creating company, special emphasis has to be put on actively connecting local initiatives. The larger the company, the more effort has to be given to this task. Two departments working on similar concepts and prototypes can cross-fertilize one another by communicating more extensively rather than duplicating work. Facilitating these connections is the knowledge activist's job. The activist must also coordinate microcommunities, bringing together the right people, forming creative communities and helping them share tacit knowledge from within. (Von Krogh, et al., 2000)

Merchants of Foresight

The activists can also assume a third role. They can be the merchants of foresight in their companies. When playing this role, knowledge activists are responsible for understanding each microcommunity's contribution to the development of the company and detecting how initiatives throughout might change its strategic posture. An activist could ask important questions about advancement versus survival strategies, competitive advantage, sources of competitive advantage, and the role of knowledge, triggering changes that might make the company's strategy a better fit for its knowledge vision. Every microcommunity has to understand its work in a broader context. They should contribute to the vision, suggesting how they might adjust their work to match the company's larger goals. This will fight myopia that often hinders the process of knowledge creation. (Von Krogh, et al., 2000)

PMO leaders

Julian (2008) sheds light on something similar to a knowledge activist, which is called Project Management Office (PMO). PMO leaders facilitate cross-project learning and continuous improvement. The research by Julian (2008) revealed that PMO leaders facilitate cross-project improvement by embedding accumulated knowledge from the past project experiences into project management routines that are utilized across multiple projects. PMOs are assigned various responsibilities related to the centralized and coordinated management of those projects under its domain. Further, Julian (2008) describes PMO as often staffed with individuals who provide some combination of managerial, administrative, training, consulting and technical services to projects and the organization overall. He claims that some suggest their mission is to improve project management effectiveness, particularly by enabling the acquisition of knowledge from earlier failures and successes and by providing a range of support and facilitative services not only for projects but also for various management levels and support units. (Julian, 2008)

2.3.4 Enabler 4: Create the Right Context

The fourth enabler, *create the right context*, involves organisational structures that foster solid relationships and effective collaboration. It influences how tacit knowledge is shared within microcommunities, the creation of concepts, and the resulting prototypes that are built. However, creating the right context has the most impact on how concepts are justified organizationally. *Enabling context* is a shared space that fosters emerging relationships. Such an organizational context can be physical, virtual, mental or all three, based on the Japanese idea of *ba* ("place"). Knowledge is dynamic, relational, and based on human action and depends on the situations rather than on absolute truth or hard facts. An enabling context, then, is a shared knowledge space, one that encourages and nurtures participation on many different levels. Yet the interactions that are at the heart of *ba* can happen at a department meeting, during a brainstorming exercise at a company retreat, via the internet, or when two professionals talk over drinks after work. These interactions can be broken down into four kinds

that influences the ways knowledge can be generated and shared in an organization. Table 3 shows these interactions in a knowledge spiral that indicates how closely connected these interactions are. This model was first introduced by Nonaka (1994), and has evolved some over the years by Von Krogh, et al. (2000). (Von Krogh, et al., 2000)

Table 3: Interactions in a Knowledge Spiral (Von Krogh, et al., 2000)

	Individual Interaction	Collective Interaction
Face-to-Face Interaction	ORIGINATING Sharing tacit knowledge between individuals	CONVERSING Having group conversations to form concepts
Virtual Interaction	INTERNALIZING Making explicit knowledge tacit once more	DOCUMENTING Converting knowledge into explicit forms

Originating

Originating interaction is how individuals share feelings, emotions, and experiences. Individual face-to-face interaction is the only way to capture the full range of physical sensations and emotional reactions that are necessary for transferring tacit knowledge. (Von Krogh, et al., 2000)

Nonaka (1994) described it as *Socialization*, and thought of it as the apprentice working with their mentors to learn a craftsmanship, but not through language, rather by observation, imitation, and practice. (Nonaka, 1994)

Conversing

Conversing allows a group of people to share the mental models and skills of individual members. This reinforces the conversion of tacit knowledge into explicit knowledge. Conversing lets participants benefit from the synthesis of rationality and intuition that produces creativity. Selecting individuals with the right mix of specific knowledge and capabilities is essential, since knowledge is created through peer-to-peer interactions. Nonaka (1994) refers to this as *externalization*. (Von Krogh, et al., 2000)

Kotnour (2000) describes *intra-project learning* as the creation and sharing of knowledge within a project and supports the delivery of a successful project by identifying problems and solving them during the project. Learning takes place when project team members discuss approaches for completing task or overcoming problems. The problems and their resolutions are saved and studied for later use. It is how we create knowledge during a project. (Kotnour, 2000)

Schindler & Eppler (2003) writes about *Process-based* methods of gathering lessons learned from concluded projects and describes two methods, Post-Project Appraisal and After Action Reviews.

Post-Project Appraisal (PPA) represents a special type of project review that includes a strong learning element. It is carried out by a "Post-Project Appraisal unit". A goal of such evaluation is to support worldwide learning form errors and the repetition of success. The team is external and have no prejudiced opinions and no interest in being an influence factor to the results of the evaluation. The PPA unit examines completed projects and analyses the entire course of the project. Such an evaluation process requires a time investment of approximately 6 months. The resulting report is submitted to team members for verifications and afterwards passed on to the review board, before being officially released. (Schindler & Eppler, 2003)

After Action Review (AAR) was developed by the US Army to help learn immediately from errors and successes. There are various formats ranging from a 20min brainstorming to a 2h discussion session.

The team is confronted with questions like: What was supposed to happen? What actually happened? Why where there differences? What can you learn from this experience? Team learning, building trust and team integrity are crucial goals of the process. The learning points could be captured on a flip chart, which is referred to on relevant occasions, e.g. before or during similar situations. Every project manager who has completed a development project could answer i.e. the same four questions. In addition, he or she must state what should be done differently in future development projects (and by whom). (Schindler & Eppler, 2003)

Julian (2008) found that a reliance on post-project reviews is doomed to fail, since this improvement structure is of low priority. It is found that the processes of knowledge capture, transfer, and learning across projects relied heavily upon social patterns, practices and processes among social networks and communities of practice. (Julian, 2008)

Documenting

Documenting is both collective and virtual. Because explicit knowledge can be transmitted to a large number of people through written documents, this knowledge mainly involves the combination and presentation of existing explicit knowledge. (Von Krogh, et al., 2000)

Nonaka (1994) refers to this as *combination* as it uses social processes to combine different bodies of explicit knowledge held by individuals. (Nonaka, 1994)

Kotnour (2000) describes *inter-project learning* as the combining and sharing of lessons learned across projects to apply and develop new knowledge. Tools to support this include information technology tools and employee groups aimed at sharing knowledge across the organization. It is how we share knowledge from one project to the next. (Kotnour, 2000)

Schindler & Eppler (2003) writes about d*ocumentation-based* methods to learn from project experiences. It focus on aspects of the content wise representation of the experiences and the storage of content within the organization. Schindler & Eppler (2003) presents three methods of how to prepare and structure the content of project lessons learned. They are Micro Articles, Learning Histories and RECALL.

Micro Articles are used to secure experiences after completion of a project. The process of making the experience explicit takes place via the authoring of small articles. The scope of the articles is limited to a half page, written in an informal style and can quote other related micro-articles. An important element for the use of such an article is the transport of the respective learning context, as the learner never took part in the particular project. They suggest the use of multimedia objects like video clips. The main idea behind the micro article is that project experience must be recorded in authentic, and yet entertaining manner, hence the magazine article style emerges as one possible format. (Schindler & Eppler, 2003)

Learning Histories is a written story consisting of the main events of a project arranged in chronological order. The resulting document can be anywhere between twenty and one hundred pages following a storytelling approach to make the recorded experience more appealing and rich of context. It is written by Learning Historians, and uses interviews to describe relevant experiences from the view of the involved individuals with direct literal quotations. Once compiled, learning histories are validated in discussion with the people involved. (Schindler & Eppler, 2003)

RECALL is an approach using a database front end to collect lessons learned. Users can submit their lessons learned directly using an internet browser. The main idea of the concept is to facilitate and automate the capture and retrieval of lessons learned. A checklist with guiding questions helps the

individual to decide whether one is passing on a noteworthy lesson or not. After the lessons are submitted, the user is asked to answer a set of questions to the system in order to add relevant context information. This meta-information enables others to find the right learnings later on according to their needs or problems. (Schindler & Eppler, 2003)

Internalizing

Internalizing is individual and virtual. When somebody reads company documentation or sees a video, the next step is for him or her to internalize the explicit knowledge presented there. The knowledge again becomes tacit based on their understanding and belief. (Von Krogh, et al., 2000)

The Spiral

Nonaka (1994) claims that each of the four modes of knowledge conversion can create new knowledge independently, but knowledge creation centers on the building of both tacit and explicit knowledge. More importantly, on the interchange between these two aspects of knowledge through internalization and externalization. Organizational knowledge creation takes place when all four modes of knowledge creation are "organizationally" managed to form a continual cycle. This cycle is shaped by a series of shifts between different modes of knowledge conversion. These cycles can be viewed as an upward spiral process creating and increasing the organizational knowledge at each cycle. (Nonaka, 1994)

2.3.5 Enabler 5: Globalize Local Knowledge

Globalizing local knowledge is the final enabler, and it is closely tied to cross-leveling, the last step of the knowledge-creation process. It emphasizes breaking down the physical, cultural, organizational, and managerial barriers that often prevent effective knowledge transfer in a multinational corporation. The ultimate goal of globalizing local knowledge must be to enhance the capacity for social action, competence, and successful task performance. The local knowledge of one unit should lead to competitive advantage for other local units, such as lowering manufacturing costs, sharing data on selected customers, distributing a common product, or employing similar training programs. Since local conditions are specific to each operation, knowledge received from another division will have to blend in with local knowledge, existing practices, and experiences. Rather than speaking of knowledge transfer, then, think of this as a process in which knowledge is globalized through re-creation at the local level, and not mere imitation. From an enabling perspective, knowledge that is transferred from other parts of the company should be thought of as a source of inspiration and insights for a local business operation, not a direct order that must be followed. Knowledge re-creation happens through a continuing dialogue among experts, and uses the received knowledge as input to spark its own continuing knowledge-creation processes. There is three phases for globalization of knowledge; triggering, packaging/dispatching, and re-creating. (Von Krogh, et al., 2000)

Phase 1: Triggering

The first step in globalizing local knowledge is to trigger the process through recognition of a business opportunity or need. There are always search costs for knowledge exchange, i.e. time and plane tickets. The challenge is to find cost-effective mechanisms for triggering knowledge exchange. Three cost effective ways could be:

1. *Bulletin boards*, the most common mechanism for knowledge exchange, can be distributed electronically or on paper. Most internal bulletins provide information about opportunities, ongoing projects, signed contracts, new products, new technologies, new employment and so forth. It should also include concrete needs of the local business under the heading "Wanted". This requires an organization that is caring for knowledge, which means organizational members actively seek from, and provide information to, bulletin boards.

2. *Regular knowledge conferencing* is another way to bring needs and opportunities to the attention of different groups throughout the company. For example, each operation is given a conference slot to assess its recent important knowledge-creation initiatives and what its concrete needs for future knowledge creation might be. The discussion can be facilitated by letting each representative present his unit's local knowledge vision or understanding of the overall knowledge vision. This will help communicating their expectations. The customer's point of view and experience can provide useful knowledge to the rest of the company.
3. *Knowledge activists* can trigger globalization of local knowledge by catalyse knowledge-creation, coordinate knowledge-creation initiatives throughout a corporation, and communicate a larger vision to everyone they meet. The activist's task as a merchant of foresight is to envision and communicate possible areas of cooperation. Activists are agile, open-minded and have a broad network. They can be commissioned by local business operation to discover expertise throughout the company, or alternatively, a need for knowledge.

Triggering could also happen more directly through internal comparative performance systems. In comparing the performance of different local business operations, managers can become aware of substantial differences. The differences can be a trigger for dismantling certain barriers or for exchanging knowledge with other parts of a company. (Von Krogh, et al., 2000)

Phase 2: Packaging and Dispatching

The packaging process is essential to moving knowledge across organizational boundaries. The only kind that can be truly packaged for distribution is explicit social knowledge. Tacit individual knowledge is more "sticky", and usually remains with its local business unit, unless the individual who hold it travel to another local operation. First, the managers involved must decide on what knowledge needs to be packaged. Only explicit knowledge that has helped the local business operation solve its tasks should be transferred. Second, dispatching managers must decide on the sequence of shipment. Can the receiving unit locally organize the explicit knowledge if it is dispatched in one batch? Do they need additional instructions? What knowledge do they need first? Third, managers should assign local experts or spokespeople to the knowledge dispatched. Explicit knowledge is only the end product. Tacit knowledge of how a document came to be is required to fully make sense of it. The explicit knowledge packaged, then, should be indexed with local areas of expertise and references to groups or individuals who can help receiving units. Fourth, managers should decide on "storage bins" as explicit knowledge can be stored in a variety of ways. Finally, managers can develop a knowledge-exchange policy to help identify the rationale for the knowledge exchange process as well as the knowledge involved and the means of packaging and dispatching. (Von Krogh, et al., 2000)

Phase 3: Re-Creating

The third and most important phase of this process involves re-creating the knowledge dispatched at the local levels, and the process can follow a number of paths, depending on the circumstances and participants. It could be a reproduction in 1:1 format, where the re-creation process strives for a copy of the original knowledge. Some objects have irreproducible features, or the explicit knowledge may be poorly documented, making the reproduction across time and space difficult. All these factors force local business operations to improvise. To reduce the complexity of the re-creation, the process could be seen as just another knowledge creation process. (Von Krogh, et al., 2000)

Cross-Project Learning

Julian (2008) adopts a view that learning produces new knowledge, and knowledge impacts future learning. By doing this, his conceptual framework distinguishes between two categories of boundary

practice. *Retrospective learning practices* include activities, processes, and artifacts aimed at surfacing, generating and reviewing knowledge from past project experiences. *Prospective learning practices* include activities, processes, and artifacts aimed at transferring knowledge from past project experiences to future projects. By establishment of both of these practices, the PMO can help their organization learn from past project experiences by embedding process knowledge into organizational routines that can be transferred to new existing projects. Figure 4 shows a conceptual framework modified by Julian (2008) for cross-project learning. (Julian, 2008)

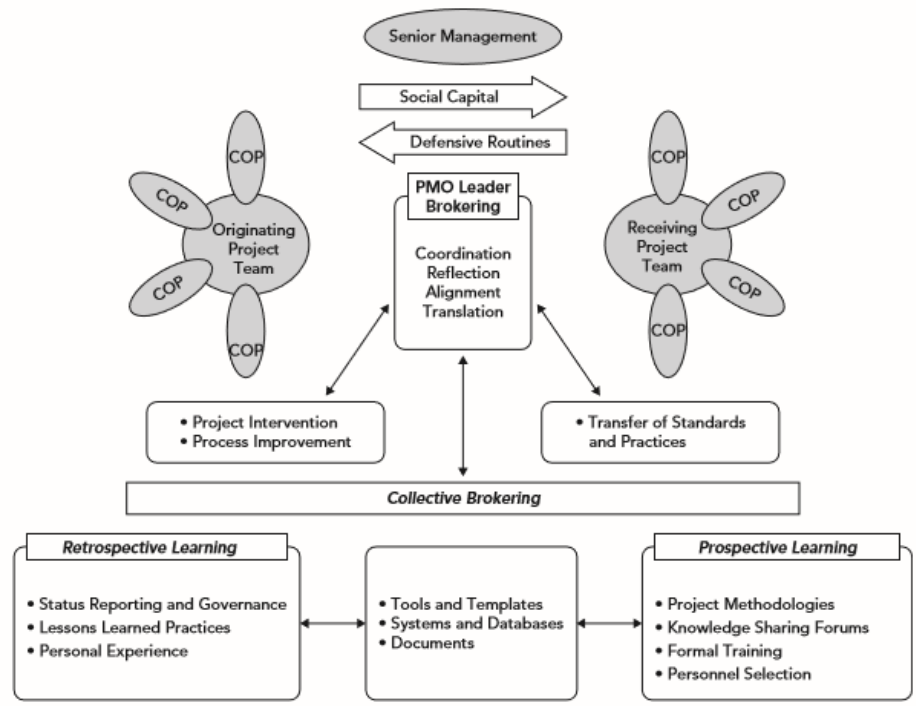

Figure 4: Conceptual framework for cross-project learning (Julian, 2008)

Brokering is defined as the process of establishing connections between communities by introducing elements of one practice into another. PMO leaders could then be expected to engage in this process of translation, coordination, and alignment among and between communities. A way PMO leaders might negotiate or share collective understandings of projects lessons learned is through *boundary encounters*. This is described as single or discrete events that provide connections across practices. Therefore, PMO leaders should also be involved in *boundary practices* whose enterprise is to sustain a connection between a number of other practices by addressing conflicts, reconciling perspectives, and finding resolutions. Boundary practices are a means through which lessons learned can be transferred from one project to another. *Boundary objects* are seen as objects such as artifacts, documents, terms, concepts, and stories, which organize interconnections among communities. (Julian, 2008)

Julian (2008) explains that social capital appears to be an important factor in the PMO leaders' ability to facilitate cross-project learning, particularly when they lack a direct line of authority over project member. A study reported insufficient authority over project teams as a major barrier to cross-project learning. The two most frequently expressed enablers of cross-project learning is a strong network of good relationships and support from senior management. Julian (2008) uses the definition of organizational defensive routines as "any action, policy, or practice that prevents organizational participants from experiencing embarrassment or threat and, at the same time, prevents them from discovering the causes of the embarrassment or threat" (Julian, 2008). "Face-saving" or lack of desire

to reflect on previous experiences is typical defensive routines caused by “red light learning” or time pressure.

Marsic (2000) characterizes situated learning and communities of practice as phenomena where learning may be tacit or not highly conscious and acquired primarily through trial and error, observation, modelling and socialization. The tacit nature of the learning that results can dilute or distort lessons learned, preventing practitioners from fully understanding the reasons for success and failure. Therefore, the informal and incidental nature of the learning that takes place within communities of practice underscores the need for structured reflective practices that focus on improving future actions. (Julian, 2008)

Mezirow (1991) defines *reflection* as a process whereby we stop and think about what we do or have done in order to interpret and give meaning to an experience. There are three types of reflection. *Content reflection* involves reviewing the ideas in the problem solving process. *Process reflection* examines the problem solving process itself, focusing on procedures. While, *premise reflection* tries to uncover the assumptions that guided the need to address the problem in the first place. This might be used as a conceptual framework by PMO leaders to negotiate and transfer lessons learned from one project to the next. (Julian, 2008)

An important issue that Julian (2008) found in his research was *red light learning*. To monitor project performance, many of the PMO leaders used a status report for management that listed projects as red, yellow or green to provide a quick indication of whether the project was meeting expectations. Red indicated that a project was failing its stated timeline, budget, and/or scope. Green indicated that it was on track, while yellow provided a warning signal. PMO leaders tended only to intervene at red or yellow light. Focusing reflection and diagnosis on troubled projects at the exclusion of green projects is a central feature of what the researcher calls red light learning. This can become enculturated as a punitive experience, making it more likely that defensive routines will be perpetuated. As the green light is ignored, they will not learn from what they are doing right. They are only asked to keep doing it, and keep the light green. (Julian, 2008)

Julian (2008) concludes that PMO leaders are knowledge brokers who facilitate organizational learning and continuous improvement in the project environment. He also concludes that organizational routines that are utilized by multiple projects can provide project organizations with a repeatable way to generate and transfer learning from past projects experiences, yet they can also constrain project teams if they are built upon lessons learned primarily drawn from failed projects. The last conclusion is that defensive routines may distort or constrain organizational learning from projects, making it less likely that future project teams will benefit from previous project team experiences. Under conditions of “red light learning”, reflective practices can become enculturated as a punitive experience, making it more likely that defensive routines will be perpetuated, further reducing their utility and effectiveness. (Julian, 2008)

3 METHODOLOGY

In this chapter, the research strategy will be presented to describe how data has been gathered and how this data has utilised.

3.1 RESEARCH STRATEGY

Yin (1994) writes that we distinguish between three strategies, exploratory, descriptive or explanatory. What distinguishes the strategies is not hierarchy, but three conditions. The three conditions consist of (a) the type of research question posed, (b) the extent of control an investigator has over actual behavioural events, and (c) the degree of focus on contemporary as opposed to historical events. These conditions are related to five major research strategies in the social sciences: experiments, surveys, archival analysis, histories, and case studies.

The first condition from Yin (1994) covers the research question. This thesis's research question focus on "how", and Yin (1994) writes that questions like "how" and "why" are explanatory and likely to lead to the use of case studies, histories and experiments as the preferred research strategy. This is because such questions deal with operational links needing to be traced over time, rather than mere frequencies or incidence.

Between these three research strategies, Yin (1994) writes that the case study is preferred in examining contemporary events, but when the relevant behaviours cannot be manipulated. Typical main sources of evidence are primary documents, secondary documents, cultural and physical artifacts, direct observations and systematic interviewing. The case studies and histories can overlap, but the case study's unique strength is its ability to deal with a full variety of evidence. Moreover, in some situations, such as participant-observation, informal manipulation can occur.

As all the sources of evidence described are available at Statoil, the case study is the chosen research strategy. However, Yin (1994) believes it is a concern that too many times, the case study investigator has been sloppy and has allowed equivocal evidence or biased views to influence the direction of the findings and conclusion. Another common concern is that case studies provide little basis for scientific generalization, as you can not generalize on a single case.

This thesis consists of a single-case study. It is used to confirm and challenge the theory presented in chapter 2 in a single-case study at Statoil. This is to analyse if there is a conceptual relation between the theories in practice. Yin (1994) writes that the single-case can then be used to determine whether a theory's propositions are correct or whether some alternative set of explanations might be more relevant. (Yin, 1994)

The unit of analysis in this study is the risk management process.

Eisenhardt (1989) writes that the goal of theoretical sampling is to choose extreme cases which are likely to replicate or extend the emergent theory. This is why Statoil where chosen. It is a huge company with many complex projects and a complicated organisational structure. It is a knowledge-intensive company with a comprehensive risk management system, and it is expected to find enough data to replicate or extend the theory in this study. (Eisenhardt, 1989)

3.2 SEMI-STRUCTURED INTERVIEW

Most of the data in the thesis is gained through semi-structured interviews. One main question was asked to help set the boundaries of the interview. The question was aimed at letting the interviewed talk of how they worked, successes, failures, and issues. The reason was to better understand their process and find issues in their management process. The main question asked was: *"Tell about how you have worked with the risk management process and identification of risks."*

The interview process was structures in two phases. The first phase involved creative theoretically oriented employees who were suggested by my external supervisor. They told of how they worked, their issues, and possible solutions to their issues. To help guide the discussion, additional questions could be asked:

- Sharing tacit knowledge: How do you facilitate meetings? How do you create a good context? How does the QRM community work?
- Creating concepts: How do you identify and prioritise risks?
- Justifying concepts: How do you reflect on the created risks? What knowledge is behind the risk assessment?
- Building prototype: What do you focus on when registering risks, and how will externals understand the risks?
- Cross-leveling knowledge: How do you and your team work to gather and share knowledge of risks? Would it help to look into another projects risk register?

Further, the information gained was structured and ideas of solutions to improvements of their process surfaced.

In phase two, practical oriented employees suggested by my external supervisor were interviewed. They talked about how they work, and their issues. In this phase the same questions where asked. In addition, a hypothesis and possible solutions were presented and discussed. The goal was to test if the presented solutions would work in a practical environment. These questions where:

- How would an assessment of strength of knowledge help your risk assessment?
- How would the way you work fit in the knowledge creation steps?
- What constrains the risk register as a source of knowledge? Bad risk titles or descriptions? Lack of context?

Ten employees were interviewed.

- Eight Quality & Risk Managers
- One Project Leader
- One earlier Document Control Leading Advisors

They have all been in different projects in Statoil, and their experience within projects in Statoil varied from 2 years to 17 years.

A project leader from another project was supposed to be interviewed, but he was not available at the time.

3.3 OBSERVATION

Observations have also been performed. It was used to gain a better understanding of the context of their processes, how they work, and how these events take place. Observations in three types of environments were performed. These were risk meetings, a risk workshop and a team building exercise.

3.4 STATOIL INTERNAL DOCUMENTS

In addition, the thesis is based on internal documentation from Statoil. These mostly contain qualitative data describing how the organisation is run. Table 4 is a summary of the documentation and data used.

Table 4: Statoil Internal Documentation & Data

Name	Description	Revised	Amount
STB	Statoil Book	05.07.2013	
STB App A	Governing document about Statoil organisation	07.10.2014	
STB App B	Governing document about Statoil decision authorities	02.05.2014	
STB App E	Governing document about Statoil capital value process	21.03.2014	
FR05	Governs the Project Development Process	07.05.2015	
FR08	Defines risk management in Statoil	29.12.2014	
RM100	Risk management process for Statoil	29.12.2014	
PDx65	Risk management process for investment projects	29.12.2014	
PDx03	Gathering of experience in investment projects	Draft	
PDx85	Transfer of experience in investment projects	Draft	
	Company reports & docs		7
	Power Point Presentations		9
	Intranet pages		-
	Mails		-
	Discussions		-

3.5 VALIDITY & RELIABILITY

Eisenhardt (1989) writes that researchers use multiple sources of evidence to build construct measures, which define the construct and distinguishes it from other constructs. In effect, the researcher is attempting to establish construct validity. In the thesis, it is done through triangulations of three sources of information, which are semi-structured interviews, observations, and primary/secondary documents. In addition to construct validity, Yin (1994) states the need of having key informants revise draft case study report. This is done by letting key Statoil personnel review the thesis's first draft. (Eisenhardt, 1989)

To confirm what Yin (1994) calls external validity, which is establishing the domain to which a study's findings can be generalized, the thesis has investigated different projects in different phases. However, Statoil is the only source of evidence and not any other company.

Yin (1994) describes reliability as demonstrating that the operations of a study – such as the data collection procedures can be repeated, with the same results. For another investigator to be able to repeat the study, this chapter is used to describe the procedures of the thesis. (Yin, 1994)

3.6 Analysis & Discussion

The thesis has explored the link between risk management and knowledge creation in the light of the empiri.

The resulting analysis is found in chapter 5, and is based on the risk management process as the unit of analysis. The analysis is structured by going through each step in knowledge creation and linking these steps to the risk management process in the empiri. The knowledge theory is used as a tool to improve the process through enablers. The importance of the knowledge dimension in risk management will thereby be analysed in the case-study by suggesting improvements for Statoil, and discussing how these improvements will affect their risk management process.

Chapter 6, consists of a theoretical discussion of how the knowledge dimension improves our understanding of risk management, and is based on the case-study as a basis for discussing the theories presented in chapter 2.

4 EMPIRI: STATOIL ASA

In this chapter, the context of the analysis performed will be presented. The Statoil organisation and its principals will be described, before their processes within capital value, risk management, and experience transfer are presented. Statoil is a huge and complex organisation and to create some limitations, their investment projects will be the focus of the empiri. The analysis will be presented in the next chapter.

4.1 INTRODUCTION

At 14 June 1972, the Norwegian government's state oil company, Statoil, was established. Today, Statoil is an international energy company with operations in 36 countries, and is one of the largest suppliers of oil and gas. They are headquartered in Stavanger, and has approximately 23 000 employees worldwide.

Statoil was the first Norwegian company to be give operator responsibility for a field. That was Gullfaks in the North Sea, 1981. Today, Statoil is by far the most valuable company in Norway with a market value at 482 966M NOK (21.05.2015). The Norwegian government is main shareholder with 67 percent and is managed by the oil and energy ministry.

Statoil is determined to be known for its high standards with respect to business ethics. In the Statoil Book, you find courageous, open, hands-on and caring to be their main values. They claim, "Our values embody the spirit and energy of Statoil. They are the core of our management system. Our values drive our performance and guide us in how we do business, and in how we work together and towards external stakeholders." (Statoil ASA, 2015)

4.2 THE STATOIL ORGANISATION

This chapter describes the Statoil organization, and the project development process. The information is mainly based on the Statoil Book including appendices A, B and E.

4.2.1 The Management System

Commitment to and compliance with the management system in Statoil is a requirement, and it has three main objectives. The first is to contribute to safe, reliable and efficient operations, and enable to comply with external and internal requirements. Secondly, help to incorporate the company values, "our people" and "our leadership" principles in everything done. In addition, to support business performance through high-quality decision-making, fast and precise execution and continuous learning. The management system (illustrated in Figure 5) is the set of principles, policies, processes and requirements that support the organisation in fulfilling the tasks required to achieve the objectives. It is documented in governing documentations, which includes the Statoil Book, common function requirements as well as requirements specific to the business area. Statoil describes their management system as the following in the Statoil Book:

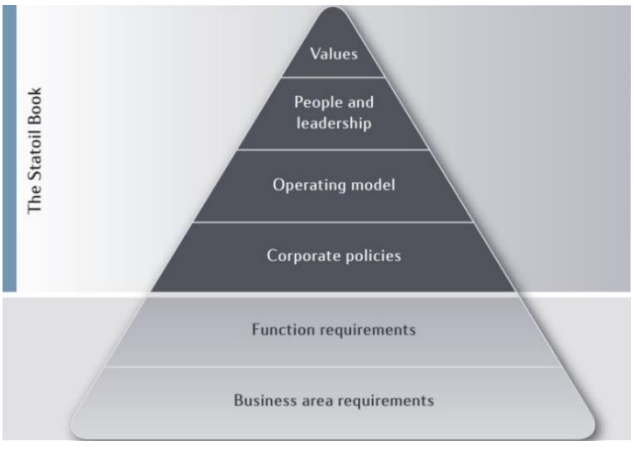

Figure 5 Statoil Management System

1. **Our values;** guiding our behaviour (courageous, open, hands-on and caring)
2. **People and leadership;** describing what we expect from our company, our people and our leaders
3. **Operating model;** describing our organisational principles, the way we work, and the way we manage and improve our performance
4. **Corporate governance;** describing governing bodies, authorities and internal controls in our group
5. **Corporate policies;** regulating our actions and decisions in important areas
6. **Function requirements (FR);** described for function and process areas as well as work processes and technical requirements
7. **Business area requirements**; describes the organisation and operating model for the business areas and other organisational units. Business area requirements also include local governing documentation related to the common function and process areas.

(Statoil ASA, 2013)

4.2.2 Organisational Principles

Statoil's organisational principles define a simple organisational design that has the flexibility to meet demands of a changing business environment. Value and performance are created in Statoil's combined asset-based and function-based organisation. Asset-based entities have a mandate to define, develop and operate assets in the value chain to ensure optimum return on investments. Function-based entities have a mandate to deliver advice, services, products, projects, and governing documentation to drive synergies and functional excellence across the group. The organisational entities have a clear responsibility and two distinctly defined roles, the line role and the support role. The line role is responsible for people, results and performance. The support role is responsible for deliveries of services, products and projects, and providing advice and expertise to other entities. (Statoil ASA, 2013)

4.2.3 Compliance & Leadership Model

The Compliance and Leadership model describes how Statoil plan, execute, evaluate and learn from any task. The five steps in the model form a systematic action pattern denoted the "A-standard". Figure 6 illustrates the Compliance and Leadership model with its A-standard and three main objectives. Leadership means active demonstration of skills in use of the model, of "our values", people partnership, and leadership principles by the task leader.

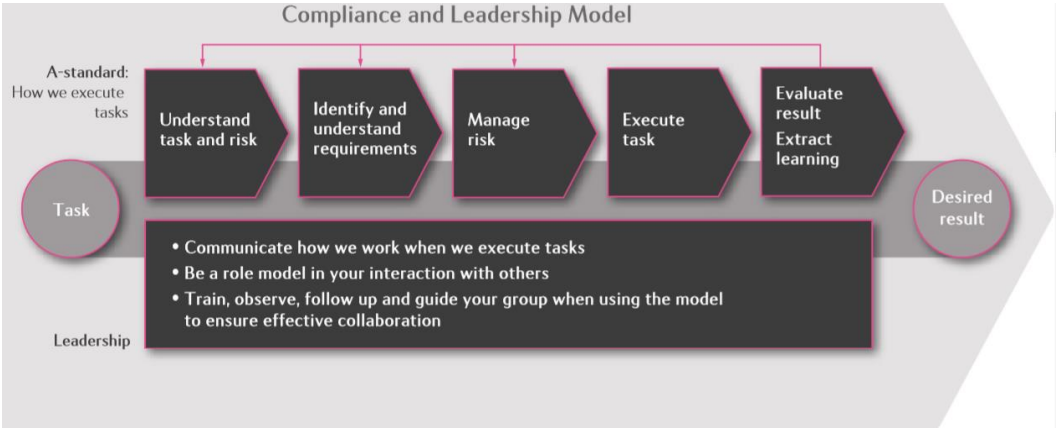

Figure 6: Compliance and Leadership Model

4.2.4 Statoil Organisation

Statoil is a large and complex organisation. The thesis will focus on investment projects in the business area called Technology, Projects and Drilling (TPD) shown in Figure 7.

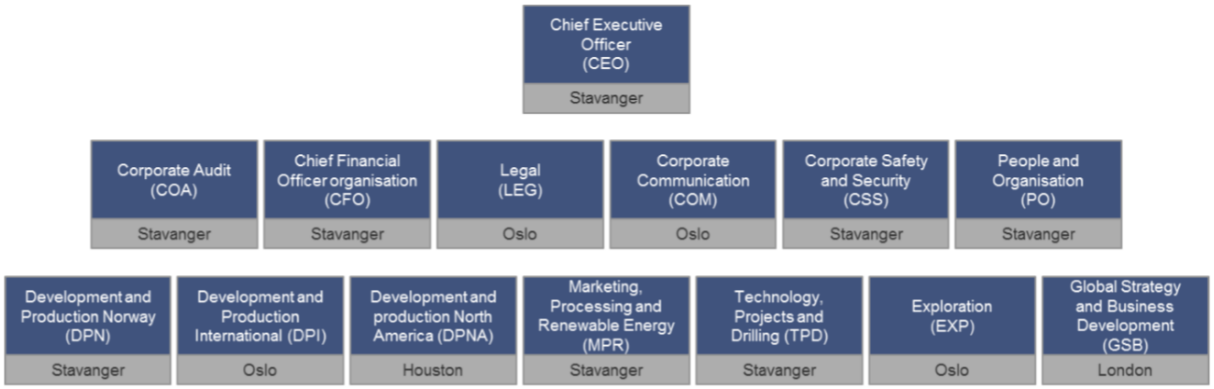

Figure 7: The Corporate Organisation

Technology, Projects and Drilling (TPD)

Statoil Intranet describes that the Technology, Projects and Drilling business area has a global responsibility for developing and implementing new technological solutions for exploration, improved recovery, field development, concept development and safe and efficient operations. The business area has ten subunits, and these are:

1. TPD Communication (TPD COM)
2. TPD Drilling and Well (TPD D&W)
3. TPD Finance and Control (TPD FC)
4. TPD People and Organisation (TPD PO)
5. TPD Procurement and Supplier Relations (TPD PSR)
6. TPD Projects (TPD PRO)
7. TPD Research Development & Innovation (TPD RDI)
8. TPD Safety and Sustainability (TPD SSU)
9. TPD Strategy and Portfolio (TPD SP)
10. TPD Technology Excellence (TPD TEX)

Figure 8 illustrates the TPD organisation as an asset business area. The Asset owner (AO) is the manager for the entire business case and appoints an Asset Owner Representative (AOR). The AOR is accountable towards the AO and is responsible for development of the business case. The AO chairs the Steering Committee, which acts as an advisory group for the AO. The Steering Committee follows up business case assumptions and context, risk and stakeholder management and strategic change management. An investment project is structured through a Business Case Leadership Team (BCLT). After passing of DG1, the functional teams within BCLT are organized as project teams headed by a Project Manager (PM). The asset owner shall ensure alignment of all activities, projects, operations and commercial aspects regarding the asset, including stakeholder management. The asset owner is responsible for issuing the decision memo and for submitting it to the appropriate management level at each decision gate.

The objective of the BCLT is to ensure aligned, effective and optimal maturing of the business case's scope of work. The BCLT manages interfaces, risks and opportunities across the total scope of work. The BCLT is headed by an AOR, and consists of project leaders from all four business cases, including a QRM to facilitate.

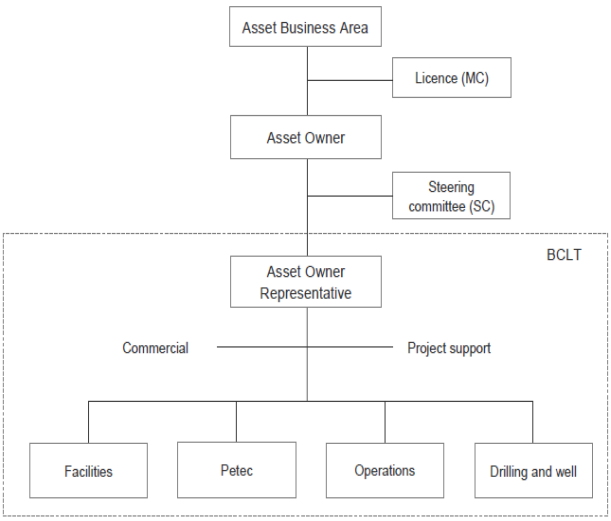

Figure 8: TPD Organisation

- *Facilities* project scope covers equipment, systems and concepts for production, processing, treatment, refining, transportation and export. Drilling facilities are included in the facilities project. This is where you will find the QRM.
- *PETEC* (Petroleum Technology) function covers all petroleum technology activities present in all phases from field development, throughout field production and ending with field abandonment.
- *Operations* (Preparations to Operations) purpose is to deliver safe, reliable and efficient operation and maintenance in accordance with sound asset management to contribute to the corporate overall objectives.
- *Drilling and Well* is responsible for all activities related to development of well design, well time and cost estimates, drilling, testing, completion etc.

Investment Projects

A business case comprises the description of a defined set of technical and commercial elements demonstrating a value creation potential for Statoil. An Investment project is established to realise and develop a Business case. Investment project includes acquisitions, asset swaps, mergers, divestments, project development and cessation. Investment projects are divided into two groups. These are *Greenfield projects*, and *Brownfield projects*.

Greenfield projects are new construction projects on new fields. These are often large projects with huge investments. While, Brownfield projects are modification projects on existing structures/fields. These are often smaller, but many projects in a portfolio and has a lower investment cost.

4.2.5 Capital Value Process

Statoil uses a decision gate process for investment projects called The Capital Value Process (CVP) illustrated in Figure 9. It is a stepwise approach for investment projects describing the process from business identification to handover to operations. Decision gates (DG) separate the phases, and the project documentation is matured in each phase to be approved before continuing to the next phase.

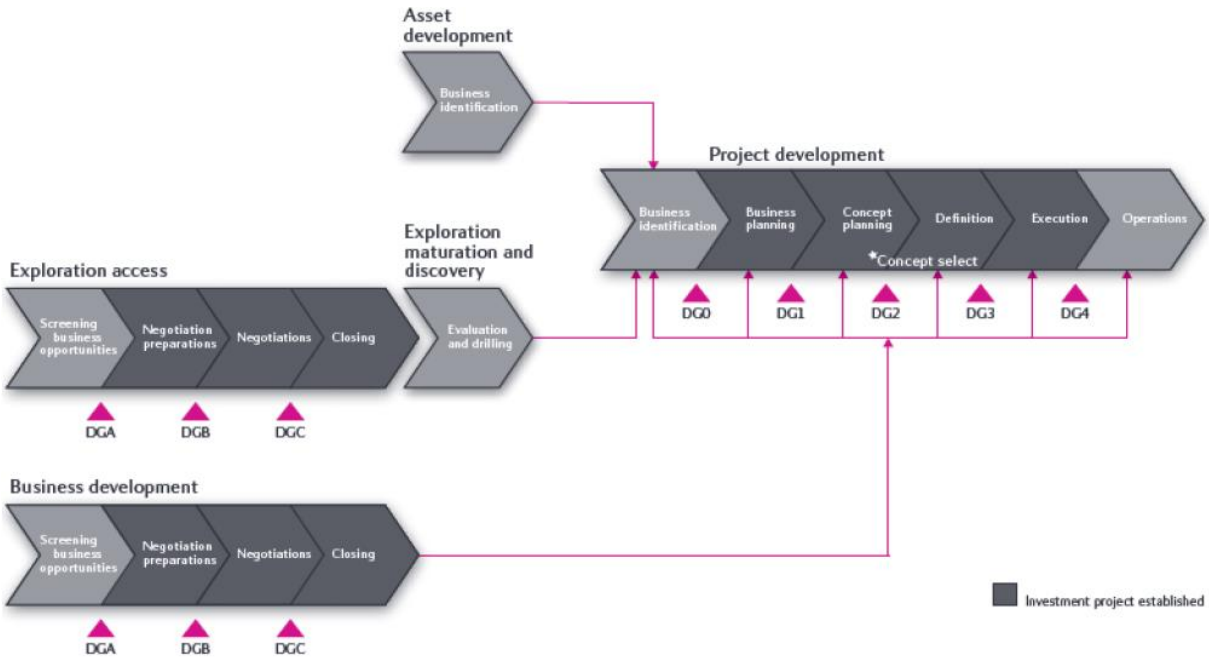

Figure 9: The Capital Value Process

Project development process

FR05 governs the project development process, and describes each step of the process. The purpose of the Project Development (PD) process is to ensure quality, predictability and competitiveness of investment projects. The PD process is a structured approach to mature and realize a business case. The process defines project management & control requirements, and identifies integration of other process requirements into one process for project development. In addition, the process defines specific functional requirements for facilities projects. The main focus of this thesis is from DG1 to DG4, and therefore will only these steps be presented.

Concept Planning (→DG2)

The purpose of the concept planning phase is to identify alternative concepts, select a viable concept, define and document the selected concept and develop design basis for approval at DG2. A concept is described with the following elements; commercial, reservoir or energy source, technical and operations. DG2 is an approval to prepare the investment project for the final investment decision.

Definition (→DG3)

The purpose of the definition phase is to further mature , define and document the business case on the selected concept for project sanction. Any options or technical solutions not selected prior DG2 shall be decided prior to DG3. In the definition phase there will be executed Front End Engineering Design (FEED) studies, the business case will be matured to avoid late project changes, and the execution phase is planned and prepared. DG3 represents the sanction of the investment project and is an approval to start the execution phase.

Execution (→DG4)

The purpose of the execution phase is to realize the business case. The phase shall detail design, procure, construct (including install), and complete the agreed facilities and wells. There will be performed a handover to Asset/Operations, and prepared for start-up, operation and maintenance. DG4 is the start of operations and will be passed when the receiving asset accepts hand-over.

Post Deal Review (PDR) or *Post Investment Review* (PIR) is a learning review and an assessment of the business case based on defined key performance indicators performed after the investment project is completed.

4.2.6 QRM

The *Quality and Risk Management* (QRM) function is located in the TPD PRO department and reports bi-weekly or monthly (as agreed) to the PM. The responsibilities of the QRM cover all of the Facilities area, therefore they also report to the AOR in the BCLT. Their role is to promote quality and risk management awareness, and a culture for continual improvement within Statoil, projects, and contractor organisations. They also promote the Compliance and Leadership way of working. In the project, some of the functions responsibility relevant to this thesis is within:

- Quality Management to:
    - Establish the experience transfer program. Plan & lead workshop to collect and communicate experience, and ensure that gathered experiences are documented. Relevant risks that are found here are registered in a risk register. Also plan & lead workshop to document and share experiences.
    - Perform cross project (BCLT) reviews of project management systems and quality and risk performance.
- Risk Management to (see chapter 4.3 for more information about risk management):
    - Set-up and administrate Risk Module in PIMS.
    - Provide risk management training for the project team.
    - Identify risks, and document these in the risk register.
    - Communicate the identified risks (which may affect the project objectives) with the management team.
    - Lead risk workshops & reviews.
    - Monitor risk register (Follow-up, reassessment and closing of risks).
    - Ensure the risk register is updated prior to reporting and generate the top-ten risk list into periodic project reports.
    - Contribute to cost-risk analysis and schedule-risk analysis session.
- Stakeholder management

The QRM provides guidance, training and facilitation when required to the project team. The tasks differ from what phase the project is in. In early phases, the QRM leads large workshops to identify all possible risks in the concepts or the chosen concept. While in later phases, the QRM facilitates project meetings identifying new risks and follow-up of the activities that are to reduce the threat of the risks.

4.3 RISK MANAGEMENT

Risk management is important for Statoil and has a high focus from the top management. The proof of this lies within The Statoil Book where risk management is mentioned several times. Even in Statoil's values, you will find something about risk management. As part of being courageous, you must use foresight, and identify opportunities and challenges. Further, it says that you must understand and manage risk. It is also stated in the corporate policy that there shall be a focus on risk in everything that is done.

The reason for a high focus on risk management is a complex industry, which involves a need for high HSE focus. There is also huge investments together with new and complex technology. In addition, investment projects could last many years from when the reservoir is found, until production.

Statoil's main governing documents on this subject relevant to investment projects are:

- FR08, that defines risk management.
- RM100, that describes the risk management process.
- PDx65, that describes the risk management process for investment projects.

4.3.1 Definitions

Statoil uses the following definitions and abbreviations found in FR08 about risk, presented in Table 5.

Table 5: Statoil risk definitions

RISK	Risk is a deviation from a specified reference value and the associated uncertainties. • Positive deviation: Upside risk • Negative deviation: Downside risk Risk is measured in: • Impact • Probability • Uncertainty defined by the strength of background knowledge
REFERENCE VALUE	Expectation, the most likely value, forecast, a percentile or a target
IMPACT	Monetary impact for the group and/or predefined impact categories for HSE Corruption and Fraud, Competition antitrust law. (Investment projects got more specific impact categories).
PROBABILITY	A measure of the chance of occurrence expressed as a percentage between 0 and 100, where 0% represents impossibility and 100% represents absolute certainty. The percentage is considered to be a knowledge-based probability i.e. by judgment, subjective.
RISK MANAGEMENT PROCESS	Establish context, identify, analyse and evaluate risk, decide actions, implement actions and follow-up risk.
RISK ASSESSMENT	Identify, analyse and evaluate risk.
RISK REGISTER	Overview of assessed risks, including risk descriptions, reference value, main contributors to risk, risk factors, probabilities, impacts, risk owners, risk managers and actions.
RISK MATRIX	A risk is expressed in terms of probability and impact, and the risk matrix is used to illustrate these two dimensions
RISK OWNER	The entity that would bear the impact of the risk and/or the person responsible for risk management in accordance with laws and regulations
RISK MANAGER	The person or entity responsible for managing risk or risk factors as risk owner or on behalf of a risk owner

4.3.2 The Risk Management Process

RM100 describes the requirements in the risk management process with the following objective: "Enable the organisation to create value and to avoid incidents." It is based on the standard ISO 31000. RM100 gives an overall risk process for the organisation, in addition, investment projects has the PDx65 that has additional requirements that must be followed. The risk management process will now be presented step by step.

Establish or Update Context

In the start of the risk management process, the project should identify the conditions and circumstances that are relevant to the project at that stage or DG. When a DG passes, the previous risk analysis should be used as an input to ensure experience transfer at the first meeting.

Identify and Analyse Risk

Through project team meetings, risks that impact the achievement of objectives or may cause a deviation between forecast and actual results are identified. Approaches used to identify risks and risk factors include checklists, brainstorming, earlier experience, records, etc. The meetings should bring different areas of expertise together for identifying risks.

The identified risks are recorded into a risk register where they are described and assigned to a risk owner. The descriptions should be specific enough to express something that can be addressed with concrete actions. The risk owner should ensure identification of required actions and an assigned action owner.

An analysis of the risks and the risk levels should be developed, which leads to an estimate of impact and probability. The analysis could be qualitative, quantitative or a combination of these, done by a team with different areas of expertise.

The impact categories described in Table 6 are pre-defined from C1 to C5 and tell how much we deviate from the reference value. Pre-defined impact categories will facilitate harmonisation of impact evaluation across the projects. As financial and schedule impact could vary depending on projects size and duration, then these categories are set by the project team.

Table 6: Impact Categories and Descriptions

	C1 (Negligible)	C2 (Minor)	C3 (Moderate)	C4 (Major)	C5 (Huge)
Cost	From ? To ? MNOK	From ? To ? MNOK	From ? To ? MNOK	From ? To ? MNOK	From ? To ? MNOK
Schedule	From ? To ? days	From ? To ? days	From ? To ? days	From ? To ? days	From ? To ? days
Prod short term*	From ? To ? BOE	From ? To ? BOE	From ? To ? BOE	From ? To ? BOE	From ? To ? BOE
Prod long term	Negligible impact on total recoverable volumes during field lifetime	Minor impact on total recoverable volumes during field lifetime	Moderate impact on total recoverable volumes during field lifetime	Major impact on total recoverable volumes during field lifetime	Huge impact on total recoverable volumes during field lifetime
Reputation	Negative exposure with limited importance	Local/regional negative exposure in mass media or from authorities and costumers	National negative exposure in mass media. Negative exposure from national authorities/regulators	Negative world wide news coverage in media. Negative attention from important organisations	Legal proceedings wit possible major legal impact. Extensive negative worldwide news coverage. Possible loss of license to operate
Safety	First aid injury or occupational illness/ effect with minor impact on health and ability to function	Medical treatment injury or occupational illness or short term psychological stress	Serious injury, psychological stress or illness with possible permanent effects	1-2 fatalities on workforce. Serious illness, psych stress or chronic exposure resulting in significant life shortening effects/ death to workforce	Several fatalities on workforce or fatalities to public. Serious illness, psych stress or chronic exposure resulting in significant life shortening effects/death to public
Environment	No or very limited impact on natural habitats. No impact on population level m only on individual organism level	Adverse short term impact on natural habitats	Adverse medium or long term impacts on a significant part of habitats (e.g restitution time 1-3 years)	Adverse long term impact on ecologically valuable natural habitats (e.g restitution time 3-10 years)	Adverse permanent impact on key ecosystems functions and services in larger natural habitats (e.g restitution time>10 years

The probability scale in Table 7 is also pre-defined, and is a measure of uncertainty to the risk.

Table 7 Probability Scale

Probability scale		
P5	Very likely	50% to 100 %
P4	Likely	25% to 50%
P3	Less likely	5% to 25%
P2	Unlikely	1% to 5%
P1	Very unlikely	0 to 1%

The risks are illustrated in a matrix (Figure 10) based on the impact and the probability. The consequence could be either positive (upside risk) or negative (down side risk) where the reference value shows a deviation of the risk.

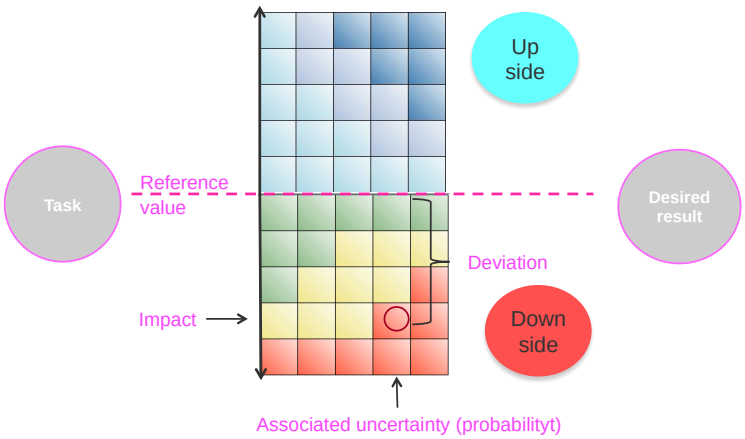

Figure 10 Risk Matrix

Evaluate Risk

The purpose of risk evaluation is to decide whether actions to retain or adjust risk level shall be initiated, and to prioritise the sequence of handling the risks. An overview is established of the top ten risks in the projects and business case. These should be reviewed and updated at least once a month, and is reported the AOR.

Decide and Prioritise Actions

If actions to adjust the risk level are needed, the ALARP Principle applies to consider the cost and benefit dimension, unless specific requirements like HSE apply. The project team identifies possible actions that will remove or reduce the downside risk deviation or increase the upside risk deviation. The action is recorded with a description and a due date in the risk register, and an appropriate Action Responsible is elected from the project team to solve the task.

Revise Risk

The Action Responsible implements actions according to the action plan and updates it when changes have occurred. The Project Risk Owner reassesses the risk to evaluate that the actions has had the intended effect on the risk. Then, the risk register and matrix are revised.

Evaluate Result of Action

If the action is evaluated as OK, the risk is revised. If not, the process returns to the step of decide and prioritise actions.

4.3.3 Risk Management Tools

This section will describe the tool PIMS Risk Module, which is used for risk management in Statoil investment projects.

PIMS Risk Module

PIMS (Project Information Management System) is a project management software for the energy sector made by Omega, and contains modules for; contract management, cost management, quality management, Risk management and much more. Customers of PIMS help participate to make the tool better and improvements are discussed at Omega conference. PIMS Risk Module (Hereby only known as PIMS) is a qualitative tool to help describe, log, and communicate risks. It is a documentation database for historic risk development, but also a communication portal for risks within a company. (Omega AS, 2015)

The tool is often used in risk identification sessions where the QRM is the facilitator to help project teams having creative discussions. After these discussions, the risk must be summarized and framed to a well formulated risk. By doing this, it should give a clearer picture of what the risk is, what is causing it and what effects it can have on the objectives. The elements cause, risk and effect are used to better framing the risks. Unlike many other tools, PIMS do not provide specific descriptive text-fields for such elements. Instead, all such elements are summarized within two fields, a risk title field and a risk description field. Omega's philosophy behind this, is that the value created by filling data into a risk tool lies within its ability to be communicated as useful information. They claim Statoil have had success with communication of risk information via titles and descriptions. Because of this, the users will need to make use of their communication skills and summarize the information in a good manner. In Figure 11 you can see the Risk Lite view in PIMS. This is the main view where all the input and editing of risk information is done.

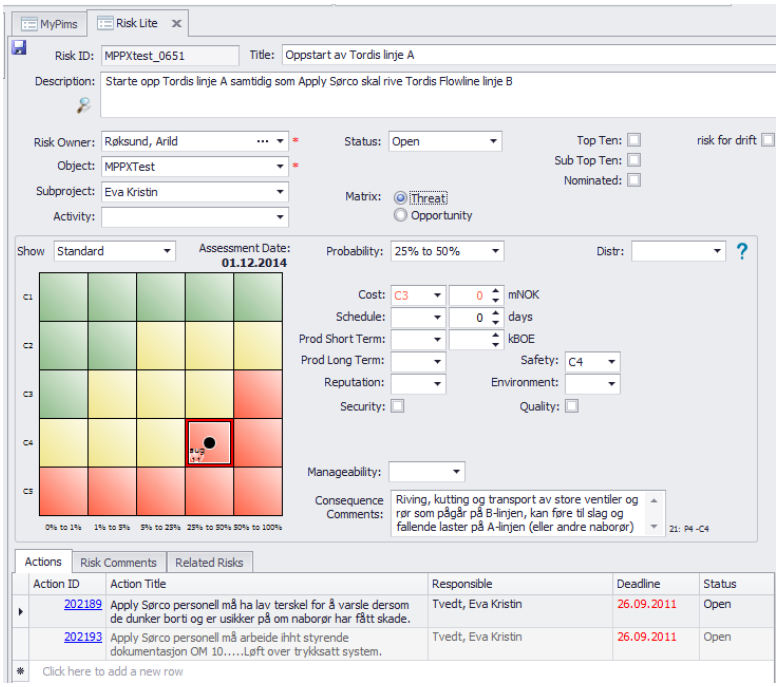

Figure 11: Risk Lite view

This view includes:

- *Risk ID*; an automatic counter to easily ID the risk
- *Title and Description field*; a qualitative text input field

- *Risk Owner;* must always be assigned so that the owner of the risk easily can be found.
- *Object, Subproject, Activity*; is used to sort the risk within the breakdown structure of the project.
- *Status Field & Closing Comment*; is used to give the risk a status of either *Open, Closed, On hold,* or *Cancelled*. When a risk is given a *Closed* or *Cancelled* status, a comment field appears to explain why.
- *Matrix type*; could either be a *Threat* or an *Opportunity* (*Upside*/*Downside*), see chapter 0
- *Probability;* is given to the risk based on the teams uncertainty and knowledge of the situation, see chapter 0.
- *Consequence categories;* includes *Cost, Schedule, Production Short Term, Production Long Term, Reputation, Safety, Environment,* and. These are given a scale, based on the team's uncertainty and knowledge of the situation, see chapter 0.
- *Cause categories:* include *Security*, and *Quality*, which are checked through a checkbox
- *Manageability, Overall Health, Consequence Comments;* are additional comments to the risk
- *Matrix;* illustrates the highest assigned consequence scale together with the assigned probability. It also shows each date the risk was reassessed and how it has moved with each assessment.
- *Flag;* risks as top a Top Ten risk, or nominate a risk as a possible Top Ten or as a potential major accident etc. Top Ten risks are reported to the AOR.
- *Time of Exposure;* gives a start date and an end date for the period when the risk can impact.
- *List of Risks;* is shown in the right pane, and contains all risks that are valid for you current filter.
- *Risk Lift;* is used to lift a risk to another management level, and owner group, a task force or an asset operator. The risks lifted will then appear in the other domain. All risk data will be copied and actions will be mirrored.
- *Action Overview & Risk comments;* shows all actions related to the risk, and in *Risk Comments* you can write key words and things that should be addressed in the next meeting.

To prevent the risk from happening or to reduce its consequence or probability, a set of actions must be applied. The team decides which actions are to be implemented, and who the responsible engineer is. The team will later have action status reviews to provide commitment to actions from team members and should improve the quality of the actions that are initiated. Figure 12 is a screenshot of the *Action Dialog* that is used when an *Action* is created.

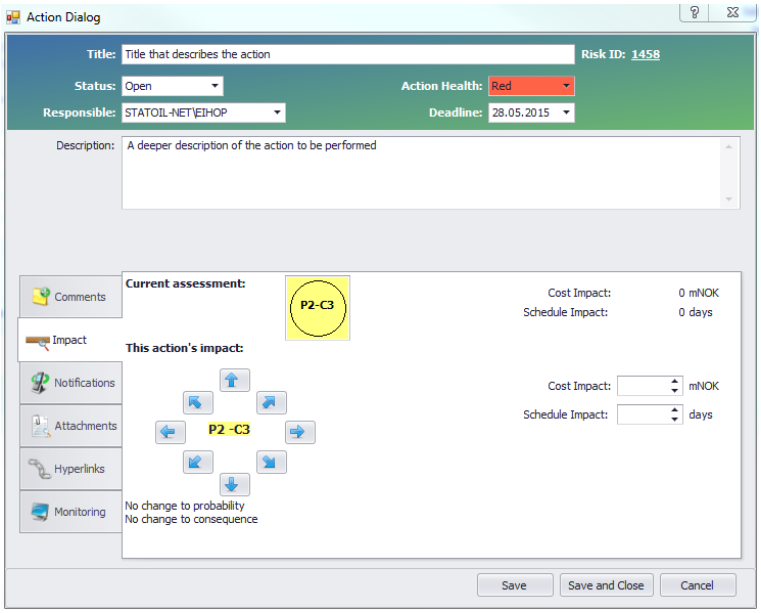

Figure 12: PIMS R4 Action Dialog

- *Title;* appears in *Risk Lite* and on reports, and should be short and descriptive.
- *Status;* can be *Open, Closed* or *Cancelled*. If the status is changed to something else than *Open*, a lessons learned box will appear. The result of the *Action* will be filled in here.
- *Responsible;* is the person that is responsible for the *Action*. Email and reminders are sent to this person.
- *Action Health;* illustrates how the action affects the risk.
    - *Red:* Mitigation action is not effective and possibly irrelevant to the risk.
    - *Yellow:* Mitigation action remains relevant, but not currently adding value.
    - *Green:* Mitigation action remains relevant and is currently adding value.
- *Deadline;* is when the *Action* should be closed. The project team reviews the *Action* and the risk when the deadline passes.
- *Description;* gives a deeper description of the action to be performed.
- *Comments;* is a place where project team members can add comments that could be valuable at later stages.
- *Impact;* is used to show how the action will impact the probability of the consequence.

Further, PIMS also has a risk list and action list that shows all of the risks or actions in the domain. This list can be sorted, filtered and used to create different reports of all the information the risks contains. These reports could be both graphical or just a sheet with qualitative or semi quantitative information. AOR/PM are considered to be information owner of their respective risk registers

4.4 Experience Transfer

PDx03 and PDx85 describe the process of experience transfer in investment projects. PDx03 tells of how to gather experience, while PDx85 tells of how to transfer experience. Through Statoil's Ambition to Action, there is a focus on sharing and improving. Experience transfer is part of the first step of the Compliance and Leadership model and requires to identify knowledge and experience that may contribute to the understanding of the task, its risks and effective execution. The last step of the model encourages evaluating results and extracting learning. Progress, gaps, experience and learning shall be assessed to propose improvements and share best practice. Figure 13 describes the cycle of experience transfer in Statoil.

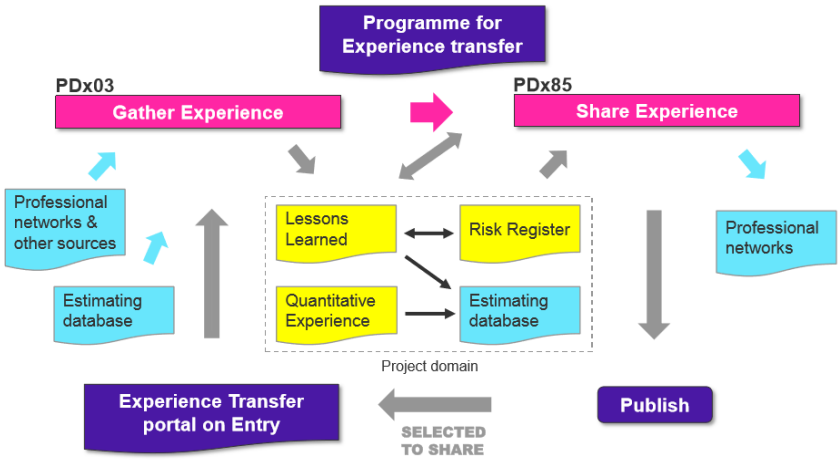

Figure 13: PD Experience Transfer Cycle

4.4.1 Definitions

Statoil defines *lessons learned* as any insight gained during a project that can be usefully applied on future projects, such as:

- An innovative method or technique that could be usefully repeated
- An undesirable result or experience that is shared to avoid reoccurrence
- Knowledge acquired from a positive or negative experience that can lead to an improvement in our governing documentation and/or processes

Benchmarking is defined as the continuous process of measuring products, services and practices/processes against those of companies recognised as industry leaders (best in class) in order to drive performance improvement.

Examination is defined as an umbrella term for a review, verification, validation, inspection or test.

Experience transfer is defined as systematic gathering, selection, communication, collection, analysis, publishing and use of experience/learnings from one's own or other's activities.

Best practice is defined as practice identified and described by the owner to be the best way of executing an activity to achieve the desired outcome.

4.4.2 Gather Experience

The purpose of this process is to gather and select previous experience relevant to the project and communicate it to project team members and relevant stakeholders. It is also to contribute to project learning and strengthen business case competiveness.

Step 1: Prepare to Gather Experience

A programme for experience transfer, covering the investment project levels, shall be established and maintained. The programme shall identify experience transfer activities to be implemented in order to gather and share experience throughout the project phase. During the planning of each project phase or activity, experience input from relevant internal and external sources is reviewed in order to update the project team on current best practices and lessons learned from previous experiences.

Qualitative experience is registered in the Experience Transfer module in PIMS for the project on an on-going basis by project team members and is not shown in the programme. The programme should identify events after key project activities have been completed and at project close-out for the phase to collect and share experience and lessons learned.

Step 2: Gather and Select Experience

All project members are responsible for gathering and selecting information relevant to their discipline on current best practices and lessons learned from other project. One source of project experience is the Experience Transfer portal on Entry. Relevant chief engineers and leading advisors can be contacted to provide an evaluation of experience upfront from other projects and bring forward relevant learning. Figure 14 shows the typical sources of experience in Statoil.

Figure 14: Typical Sources of Experience

The responsible quality management will provide project team members with training and guidance on how to gather and select qualitative experience records. The quality management may be requested to facilitate workshops and meetings to help promote experience transfer.

Step 3: Communicate Experience

Communicate experiences within the project systematically and without undue delay to update the project team on current best practices and lessons learned. Regularly review and update the project risk register in the light of new experience collected. Experience transfer meetings may be arranged with other projects and professional networks to communicate experiences and promote mutual learning.

4.4.3 Share Experience

The purpose of this process is to collect and share experience, and contribute to organisational learning and strengthen company competiveness.

Step 1: Prepare for Collection of Experience

The AOR is responsible for initiating experience collection in accordance with the programme for experience transfer. Quality management assists with planning, arranging and facilitating of workshops (as required) in close cooperation with the AOR/project manager.

Step 2: Collect Experience

The project manager is responsible for ensuring that the experience published on the Experience Transfer portal on Entry will be value-adding to other projects. Quality management will provide project team members with training and guidance (as required). It is individual project member's responsibility to add experience records on an ongoing basis. Facilitated workshops and meetings are used to promote experience transfer. The project members take part in collection and sharing of

experience and are responsible for adding new experience records to the Experience Transfer module in PIMS for the project on an ongoing basis.

Step 3: Share Experience

Quality management facilitates workshops to identify experiences that have been registered in the Experience Transfer module in PIMS and which are to be published to the Experience Transfer portal on Entry. The workshops are identified in the programme for experience transfer. The project members is responsible for ensuring that discipline specific experiences have learning value and are shared and discussed with their professional network.

4.4.4 Qualitative Tools

Statoil has two qualitative tools with a main purpose of registering and transferring experience. These tools, Experience Transfer Portal and PIMS Experience Module, was launched early 2015 with the purpose of enabling rapid and efficient experience transfer.

Experience Transfer Portal

The Experience Transfer Portal is used for sharing qualitative experience from Investment, Modification and Business Support projects. It is public to everyone in Statoil at the intranet (Entry) and contains data uploaded from PIMS Experience Module (the same data as illustrated in Figure 15). The portal focuses on searchability and user friendliness.

PIMS Experience Module

PIMS Experience Transfer module in the project domain is only available for project members in that domain. It uses the same program and domain as the risk register and makes it possible to link risks to the experiences made. Experience editor is where you add, edit and publish experience. Experience list lists all experiences in the domain. Here you can make reports to excel files. Figure 15 illustrates the input sheet where the experience is registered, and when you are finished a “publish” button publishes the experience to the Experience Transfer Portal making it public to everyone in Statoil. There are two roles in this software, the user and publisher. The user is project members who are given the authority to add and edit experiences in the project domain. The publisher is e.g. project QRMs or project managers who are quality and publishing responsible.

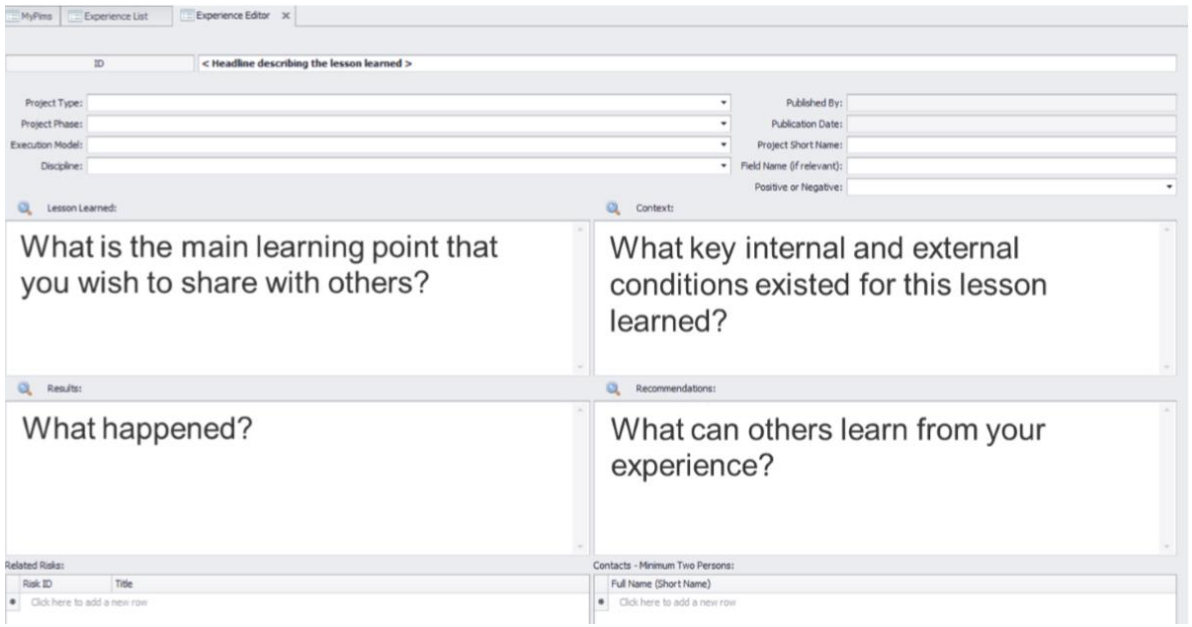

Figure 15: Experience Editor Input Sheet

5 ANALYSIS

In this chapter, knowledge creation and enabling will be analysed in a Statoil risk context. The analysis is based on theory from chapter 2, Statoil processes & tools from chapter 4, and qualitative data gathered through interviews with Statoil employees. The analysis is divided into knowledge creation steps with the purpose of analysing how knowledge enabling affects the risk management process in practice. The analysis also focuses on helping Statoil improve their existing risk management process.

5.1 THE KNOWLEDGE DIMENSION IN RISK

I wish to start the analysis by looking at Aven's (2013) knowledge dimension in Statoil's risk assessment context.

Both Aven & Krohn's (2014) and Statoil's definition of risk includes a knowledge dimension that tells something of the expert's uncertainty about the consequence or probability assigned to a certain risk.

Statoil writes: *"Risk is measured in: Impact, Probability, and Uncertainty defined by the strength of the background knowledge."*

While, Aven & Krohn writes: *"Risk is described by specifying the events/consequences (C') and using a measure (Q) (interpreted in a wide sense) of uncertainty, leading to a risk description (C',Q,K), where K is the background knowledge that C' and Q are based on."*

The knowledge dimension is not included in Statoil's risk assessments in PIMS. This could lead to a misconception for those making decisions in the company. They do not know what knowledge the assessment is based on, and how much time has been used to investigate before the probabilities and consequences where chosen. One of the main issues commented in the interviews is the time pressure. Neither the engineers, nor the project leaders have enough time to gather information about the different situations. That leads to risks that are based on poor knowledge without the decision makers knowing it. The probability assessed tells of the chance that the event will occur. However, it does not tell of the assessor's uncertainty of that probability, and the probability stated could be wrong.

By adding the knowledge dimension in the Risk Lite menu, there could be a higher focus on the importance of knowledge. The decision maker will better understand that the decision he is supposed to make could be based on poor knowledge and almost no research. Thereby, he could decide to apply more resources to investigate the risk. For the project team, this could lead to a larger focus on gathering and sharing knowledge or information in an effective way within the organisation, which then could lead to a stronger knowledge of the situation. They could also gain more time and resources from the decision makers.

Aven (2013) suggests a method for assessment of the strength of knowledge. A crude direct grading of the strength of knowledge is most efficient according to the context. The method is simple and not very time consuming. Time issue is already restricting the risk process and by adding a new feature that is time consuming could be met with resistance by the project team. The risk process used by Statoil is a simplified risk analysis (see 2.1.1), and a crude assessment of knowledge by answering a few well-defined questions should be enough.

In the interviews, all QRMs spoke positively about adding a knowledge dimension to their risk, when presented. A QRM stated that he often had to put risks aside, not implementing them in the risk register, as they did not know enough about the risk. They were afraid the risk would steal too much

attention or be misunderstood. Adding the knowledge dimension and making "knowledge creating" actions could be a solution to the issue.

Through discussions with Leading Advisor of risk management, it was argued that a more practical solution for assessing strength of knowledge is needed in Statoil compared to Aven's (2013) suggestion. The discussion ended in a suggestion that Aven's (2013) method defines the basis of an excel sheet for the QRM, where different statements are written. These statements could be used as a list to reflect on the origin of the risk and what actions could be done to generate a stronger knowledge of the situation. Each statement gives a score, and the total score leads to a suggested strength of knowledge in the excel sheet. However, the project team must decide itself what strength of knowledge they believe they have, as scores from the sheet may not be correct in every situation. Statements could consist of asking questions about:

- What analysis has been performed (all types of analysis that Statoil uses are listed, each as their own statement)
- If any of the typical sources of information provides reliable data to the risk (listed in Figure 14)
- Which experts has been brought in, and if there are agreement/consensus (listed in Figure 14)
- Where the risk originated, and if it was found through an analysis or was just an idea from a team member.

These statements are knowledge creating activities, and create a basis for the knowledge creation process. The next section will look at how the knowledge creation process can be enabled in Statoil.

5.2 Setting the Context of the Analysis

Risk identification and assessment in Statoil is usually done through meetings and workshops. Workshops are often used as a place of creativity to identify new risks or actions as the project goes into a new phase. It involves all of the technical engineers, QRMs, and a project leader. They sit down together in groups of 5-10 people per table and try to find every risk that could happen in the project within a given context. In workshops, the risks are neither made into prototypes, nor justified properly. It is just a creative process. After the workshop, all QRMs could sort the risks identified into specific disciplines and invite only those relevant within that discipline to a risk assessment meeting. In these meetings, the context is narrow and specific within the discipline. Again, tacit knowledge is shared, maybe based on more research on the risks identified in the workshop. Concepts like probability, consequence, and even new risks are created. Further, the concepts are justified by the members in the meeting, and this could end with some of the risks being "thrown away" as unnecessary or not relevant. The risks that passes, is implemented as a prototype in the risk register. Depending on the importance of the risk or discipline, a new assessment meeting is done weekly or monthly. Again, in the next meeting, the knowledge creation cycle applies again as new tacit knowledge is acquired and shared within the assessment team. Some of the created concepts end in revised risks with a stronger knowledge, while other concepts become new risks that recently have been identified. This way, each meeting ends with a stronger knowledge of the risk. It could be new actions or a revised assessment of consequence and probability. This is roughly Statoil's risk process seen in a knowledge creation perspective. Know that the Statoil risk process includes much more, and this is just a brief description of risk identification and assessment.

5.3 KNOWLEDGE CREATION PROCESS

This part focuses on the link between the Statoil risk process and the knowledge creation process and its enablers. Through interviews with Statoil employees, issues with the risk process have surfaced. Most of these issues will be mentioned here, but only a few of them will be focused on by discussing alternative solutions. We will centre the analysis around their risk register by using the knowledge enablers in a risk context, in an attempt to gain a stronger knowledge. Figure 16 illustrates a suggestion to a knowledge creation process that will be used in this analysis.

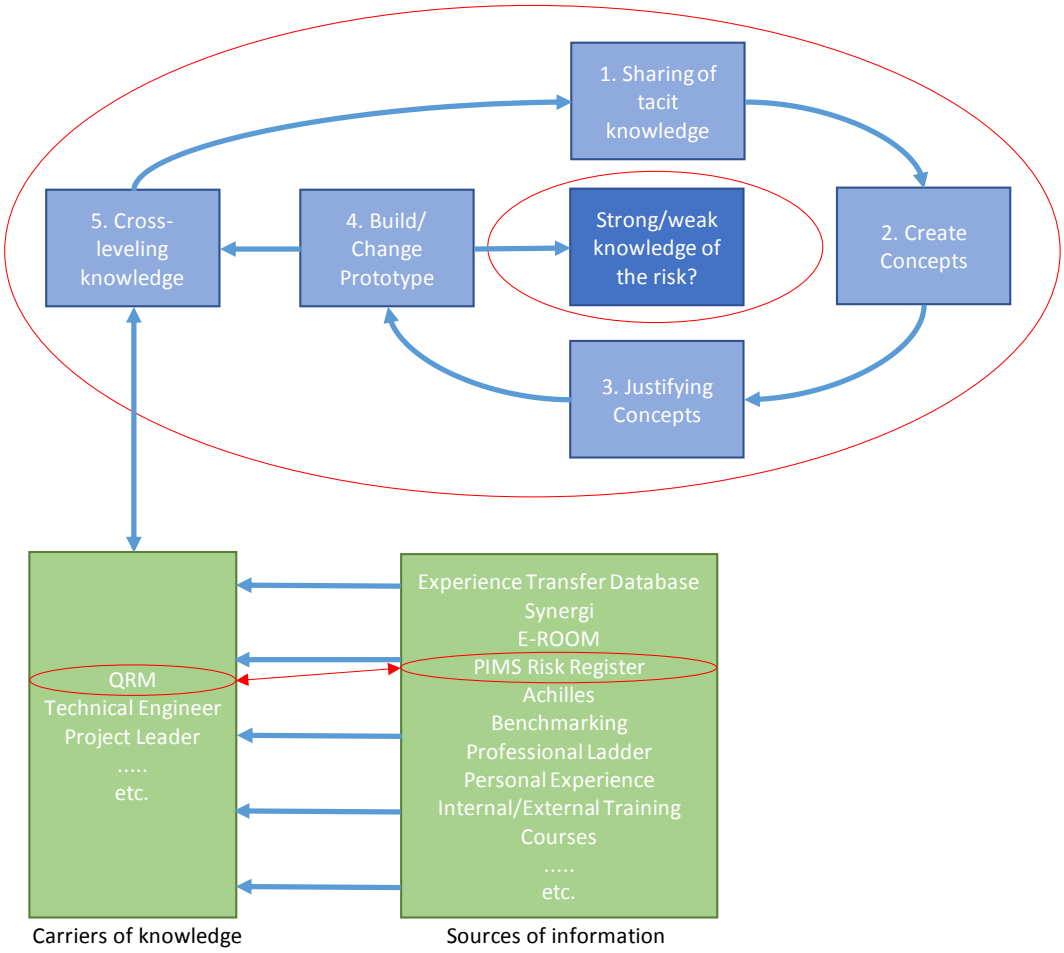

Figure 16: The knowledge creation process in a risk context

First, the project team should gather relevant information and personnel for a risk meeting/workshop, and tacit knowledge is shared between the individuals. Through conversations and discussions are concepts created. These concepts could be positive or negative events that the team believe may occur in their project. The events or concepts are thereafter justified by the team members, based on the knowledge available (gathered). The team members must justify their personal belief of the situation in front of the other members, and through agreement or common understanding, a prototype is created. The prototype is a new or revised risk with its applied consequences, uncertainties and activities that is documented in the risk register, PIMS. Further, the risk or prototype could be helpful to other project teams and a valuable input to their process, either to help their creativity creating new concepts or to better justifying their concept. Therefore, the knowledge gained must be globalized in an effective way. This continuing process is a spiral that leads to stronger knowledge in a company. So how do we best enable knowledge creation in each step?

5.3.1 Sharing Tacit Knowledge

Sharing tacit knowledge is the first of the five steps in knowledge creation (see Figure 16). In a risk context, it includes every situation both on the inside and outside of Statoil where project members meet to share their knowledge of risks to a given technical, commercial or organisational area. Typical important physical spaces in Statoil for sharing of tacit knowledge about risks are in risk meetings, workshops and communities.

Internalizing (Creating the right context)

I wish to include the step of internalizing from chapter 2.3.4, as this is how each individual understands the explicit knowledge tacitly. The explicit knowledge could be from PIMS, Experience Transfer Portal or other relevant places. The way an individual understand explicit knowledge, is shared as tacit knowledge with other individuals, even though that understanding may be wrong. This emphasizes the importance of justifying knowledge, as individual's tacit knowledge may be wrong.

PSA and the government found that accidents have happened because of Statoil's fragmented understanding of risk. In Brownfield projects, they recently introduced a new model for joint operational risk management in one of their projects to improve their overall understanding of risk across disciplines. They found that people lack the competence to understand the connections between risks across disciplines. In addition, if one share tacit or explicit knowledge with a person who lacks the competence to understand this knowledge. What tacit knowledge does he or she gain?

To make the model succeed, they had to increase the general technical competence of the project members to make them able to discuss technical details across disciplines. This would make them better suited to understand if the other disciplines' risks would affect your own risks. The issue of not stopping to reflect and look across disciplines has surfaced in many of the interviews with Greenfield QRMs. Therefore, it could be helpful to increase the general competence of all Greenfield personnel, as part of the knowledge creation process. What Brownfield did, was to increase individual's competence to a common minimum level. If not, the receiver would not understand the tacit knowledge that is transferred. There had to be close interactions between experienced and less experienced personnel. They started a peer assist program to help increasing a person's competence in other technical fields. In the end, they succeeded in getting an improved communication across technical fields.

Aven & Krohn write of the importance of competence based on theory to properly understand risk. They say that rational prediction requires theory and builds knowledge through systematic revision and extension of theory based on comparison of prediction with observation. Without theory, experience has no meaning, and without theory, there is no learning. You perform and compare the outcomes with the theory, and there will be a continuous improvement process (using the basic steps: plan, do, study, and act), which may cover adjustment/developments of the theory and how to interpret it in practice. This is a useful perspective and way of thinking for the proper understanding, assessment and management of risk. (Aven & Krohn, 2014)

QRM's Community

Sharing of tacit knowledge is not only about sharing in a risk meeting or workshop, but also about sharing within different communities in Statoil. Knowledge shared in communities or other places with the proper context can then be brought to the next risk session for further discussion.

There are many communities in Statoil that can practice or already practices sharing of knowledge, either within or across disciplines. The focus is on the QRM as they already have an important role in experience transfer and it seems to be a challenging role in the project team. This could be because of

the need for a broad competence. However, with the right interpersonal skills and experience they could grow into an important role, who could be the difference between failure and success in the project.

When a QRM was asked about networking with QRMs in other projects, he told that it is an important personal goal for him to build a network within the organisation. I.e. he uses the network meetings with the other QRMs to listen to other peoples issues. He uses what he hears, and maybe calls the person he heard it from afterwards to discuss the theme further. Thereafter, the information acquired is used as a contribution to the team meetings. He believes the QRM has a good overview in their own projects and are not restrictive to share.

Another QRM believes that the QRM is one of those who know their project best and has a good overview (except from the project leader). The QRM community is strong, she explains, and we are good at sharing. I.e. we share practical products like appendices in contracts and so on. Further, she thinks it could be interesting to share chosen top 10 risk pictures in QRM network meetings. The reason is that the top 10 risks shows what is in focus in each project, and these could be very different from project to project. Discussing and reflecting on the risk pictures could be helpful both for the QRM presenting them, and for the other QRMs that may think, "We haven't thought of that!" While others may think, "We have the same risk! What actions do you have? Is this something we could cooperate on?" She further explains that everyone uses some of the same suppliers, and we have to be better at communicating and coordinating. Not every project can require an audit from the supplier when we have the same suppliers.

QRM Microcommunities of Knowledge

Julian (2008) defines *communities of practice* as groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis. In Statoil, this could be all of the smaller project teams within a project, who shares issues and risks in a technical area.

On the other hand, Von Krogh, et al., (2000) talks of the importance of *microcommunities of knowledge*. These are small groups within an organization, whose members share what they know as well as common values and goals. Further, they state that the communities are not limited by group, department, and division boundaries, but may overlap within and across them. The QRM community could be looked at as a community of knowledge. Here, the QRM shares lessons learned and experiences from communities of practice in their own projects. Through interviews, this seemed to already be practiced in a quite good way, especially in brownfield projects. There are monthly meetings where risks, mostly top 10s, are presented and discussed. The meetings are open for all of the QRMs.

However, the community may be too big for effective sharing of relevant knowledge. Von Krogh, et al., (2000) writes that larger communities of knowledge can share certain practices, routines, and languages, but for new tacit knowledge to emerge through socialization, the group must be small: five to seven people. The focus is face-to-face interactions, and gradually members get to know more about each other's personalities, fields of interest, possible agendas, and the corresponding behaviour. A microcommunity of knowledge has more potential to evolve over time rather than being project-or deadline-driven; as such, it will develop its own rituals, languages, practices, norms and values. This supports the need for microcommunities of knowledge within the QRM community. The participants of the microcommunity should not be working within the same project, but in the similar technical areas or have earlier worked in the same area. Those sharing a microcommunity of knowledge could also have a common social understanding that will help building trust and relationships. Strong relationships between individuals would make sharing of tacit knowledge easier according to Von

Krogh, et al., (2000). At a QRM team building event, the QRMs were divided into groups of four to five people. In these groups, they shared information about their strengths, weaknesses, and what they believed was their biggest success as a QRM. The discussion observed was great, and it seemed they learned a thing of two from each other. This illustrated the power of knowledge sharing within small groups.

When a microcommunity is created, it would be recommended to interact at a weekly basis and having monthly meetings. At the monthly meetings, they could present the context of their project, their issues, and possibilities. Thereby follows a discussion and sharing of tacit knowledge, which could end in a solution. Through trust; risk registers, E-Rooms and other sources of information are shared, both from current and earlier projects. This makes explicit knowledge in Statoil more available, easier to find, and easier to understand. By time, the microcommunity can build a strong common knowledge that can be utilized in their project, hopefully making them a more important team member in their project.

Below in Figure 17, the relationship between a community of practice in projects, and microcommunities of knowledge formed by QRM participants is illustrated. Blue dots are QRM personnel, while the green dots are project team members.

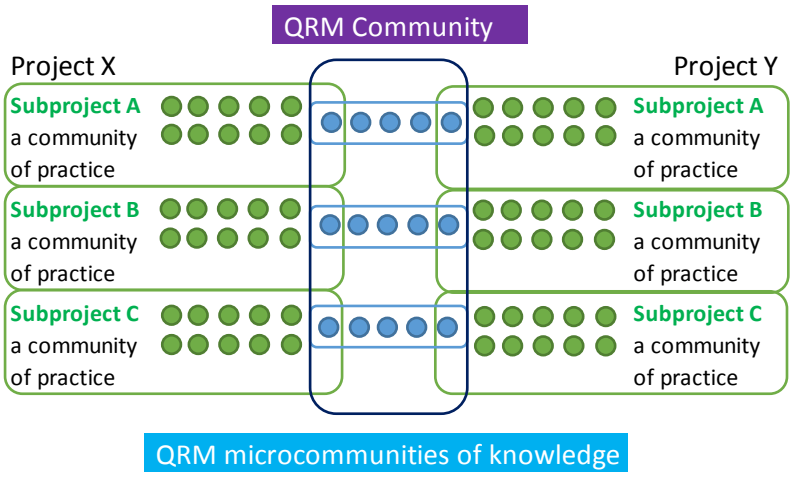

Figure 17: Relationship between communities of knowledge and practice

Issue: Finding the Right Person

Some believe there is an issue finding the right persons who can share a needed tacit knowledge.

A QRM told of his experience with this subject. He told that before he entered the project, the risk register was created by the use of brainstorming workshops. Here, highly experienced personnel and experts from TEX were gathered. He said that there are not any procedures on how to find and gather the right people from the outside of the project, like people from TEX. This is usually a local initiative within the project and could be different from project to project. In this case, people high up in the organisation wished for an effective construction and therefore added expert personnel from the outside of the team. Some believe it is the Technical Discipline Engineer's responsibility to gather relevant expert personnel from outside of the project, if needed. However, some believe it is the QRM's responsibility to catalyse these interactions. However, finding the right persons who share their tacit knowledge is an important step in creating strong knowledge about a risk.

Nevertheless, a proposed solution to this issue surfaced in an interview with an earlier Leading Advisor of Document Control. She told that Statoil has Document Managers who are experts at finding information throughout the organisation, and across projects. None of the QRMs interviewed told of this role. Do the QRM know how helpful this role could be? She also told that every revised organisational chart is kept in a database, so finding a specific person in a project at a specific period of time would be easy for the Document Manager. This could be quite useful, as I have noticed an extreme rotation of members in one of the projects the last year.

However, bringing people from other projects to help in your own project is not always easy. A QRM stated, "People are busy, and we need to have respect for their time." If a person was relevant, and if he had time, he would talk to that person first before bringing him to a project meeting to share their tacit knowledge. The QRM believes that there are good possibilities to look across projects for help, but time is a limitation. A benefit, he believed, would be that the person brought to the meeting as an outsider would be seen as some kind of expert at the area that everyone would listen.

Another QRM told they had a workgroup whose task was to ensure information from those working in operations. Operations have an experience database with operational experiences. It was important to establish this group early on and ensure it contained people with a network within Operations. It was clearly a success factor at her project. In that project, they had people from Operations who was experienced and could tell the project team what was needed, and what they did not need. This way, they were able to remove unnecessary components and save the project for a lot of money and weight. This was only because they were highly experienced. To receive this experience and creativity was important and an experience database would never manage it.

5.3.2 Create & Justify Concepts

Based on the project team's ability to share the tacit knowledge, the next step is to create new risk concepts and justify them. At this stage, the concept may be a new risk that has surfaced, a new action for a risk, or knowledge that leads to suggestions of a new consequence or probability for an old risk. In the creation phase, knowledge is needed as inspiration to trigger creativity to all risks. While in the justification phase, project members should use all available information including company's vision and strategy to build arguments for or against the concept.

Both the project leader and QRMs interviewed thought their teams are creative and good at identifying the most important risks. However, some told they are not good enough at identifying good actions that reduces the consequence and probability of the risk. The reason for it could be a lack of knowledge about the situation, which leads to poor actions. Further, the reason for the lack of knowledge could be the lack of time to do research, which it seems that everyone suffers from. This leads to the need for an effective knowledge creation process where the team feel they are not wasting their time. Schindler & Eppler (2003) think that due to projects special nature as a secondary type of organisational form (e.g. limited time and resources, pressure, great complexity, new teams), projects are especially suitable for learning.

Creating the Right Context

Three of the more experienced QRMs interviewed could not stop talking about the importance of creating the right context. It is also the first step of Statoil's risk process and an important knowledge enabler in Von Krogh, et al.'s (2000) theory.

One of them told that the most important thing for him in a risk identification workshop is to have clear goals. The risks you define should be in accordance with the project team's goals. If a team does not have any goals, then what are they trying to achieve? In addition, are the goals understood? To

achieve a shared understanding in a risk workshop, you must start by building a common concept that will make a better understanding of the context. Aven & Krohn (2014) agrees to the QRM in their "new way of thinking of risk" (2.1.5), where proper concepts are important to be able to have a language for the adequate understanding of performance and risk, and related terms. Another QRM also agreed as she spoke of how helpful it was to establish a good context to understand what they actually were talking about. It was when a proper context was established, the pieces finally fell into place. She believed it important to be conscious of people's different perspectives and bring them together to a common one. The context will change as you move into new phases in a project, from identifying risks through creativity or to what Aven & Krohn (2014) calls collective mindfulness in later phases.

An important issue is the focus on only technical risks and their interactions, a QRM believed, as organisational and human risks are easily forgotten. He further stated that we do not have an understanding of those risks, i.e. that people must communicate beyond country borders. What is the most important focus when identifying good risks, the technical, organisational or human risks? It is possible that many of the technical risks appear because of human and organisational errors, and a solution could be to be conscious of also creating a context (a mental space) for identifying these before they occur. It would be an important task for the QRM to not only create a mental space for technical risks, but also organisational and human risks. Having meetings with a context that focus on cross-discipline risks are also important, as risks with interactions between disciplines often are difficult to identify.

How to create the right context is different from situation to situation, and is used in all phases of knowledge creation. In creation of concepts, the context should embrace creativity in the team, while in justification of concepts it should embrace the need for concrete information and factual arguments. It is recommended for further research to find how to create the right context in different situations, as it seems to be an important enabler for knowledge creation and risk management. A good start is to be mindful of it and know the importance of it.

An issue where the project team not always understand the experience that is transferred from another project was spoken of. The shared tacit knowledge from the previous team is created into a misunderstood concept or an underrated concept that does not take the risk issue seriously enough. They had a problem putting themselves in the same situation. The cause of this could be all of the four knowledge problems; complexity, uncertainty, ambiguity and equivocality. Johnson-Lard (1983) writes that human beings create "mental models" of the world based on schemata, paradigms, beliefs, and viewpoints that provide "perspectives" that help individuals to perceive and define their world. In this situation, it seems these "mental models" are not properly understood by the receiving part of the tacit knowledge. Both understanding the context of knowledge shared and putting this knowledge into a new context is important to do in an effective way, avoiding the four knowledge problems. How to share and understand knowledge will be discussed further in chapter 5.3.4 Cross-leveling Knowledge.

Managing Conversations

The QRM has an important role as a facilitator in the management of conversations. In a workshop or a risk identification meeting, it is usually a discussion around the table where each individual shares their point of view about the concept. I.e. are drilling & well concerned with well instability, while Petec believes something else is more important. A QRM told that it is hard to get to an agreement, because of all the different opinions and backgrounds.

All the interviewed believed the QRM should be good at facilitating to extract all the tacit knowledge needed, and make people reflect on what the other team members say. They should know what knowledge that must be extracted, use the context and ask silly questions. Silly questions would help

the conversation stop, and make people think about things that they usually would take for granted. It is especially important in teams who have worked together for a long time and have started thinking in a similar way, forgetting to question their methods. A QRM told about how people act in group discussions. He said that he believed people dared to be creative, and to question each other. There are a lot of nice people and good leaders, but maybe too many nice people with too nice questions, not contributing with enough concrete criticism to the discussion. He also believes the project leader should listen more than he talks, reflecting on the participant's knowledge, which means that the QRM should be the conversation manager making it easier for the project leader to listen and reflect.

This is one of the reasons the QRMs should be good facilitators, and Leading Advisor of Risk Management has planned to start a facilitation course for a few selected QRMs to make them experts of facilitation. However, a Project Leader told that the QRM needs a very special skillset both technical and interpersonally, which makes it a challenging role. Those who have it could become the Project Leaders important "right hand", while those who lack it could become an "advanced secretary". I really suggest this topic for further research, to find what type of persons make a good QRM. Personality seems to be important and a natural talent within interpersonal skills.

Von Krogh, et al., (2000) suggest a conversation manager to lead by four principles for managing conversations. In Statoil, either the project leader or the QRM could assume such a role in the team, but a suggestion for the project leader is to sit back and listen while the QRM manages the role. The principles for managing conversations is described in chapter 2.3.2 and suggests to first make entry points for team members to enter the conversations, then establish a conversational etiquette, edit conversations appropriately and last to foster innovative language. I will not focus more on this part as I believe that further research must be done. I support the idea of a facilitation course for the QRM to make them a good conversation manager. It may be one of the most important enablers for tacit knowledge to be shared and make the knowledge creation process function. Von Krogh, et al., (2000) suggest in Table 2 conversational guiding principles for knowledge creation. I believe these are good principles for managing a conversation, but I do not believe it would help a QRM just to read them or for me to explain them. Further research in the area should be done and facilitation course would be most helpful.

Justification of Concepts

When the project team is to justify the concept, it could be problematic as some people may be afraid to share their personal beliefs and justify them in front of the team. In addition, those who justify their beliefs could be met with scepticism or be overheard. A QRM was in such a situation as his concerns were overheard, as the team did not believe the QRM had enough knowledge to support his bold claims. An unexperienced QRM must have data that supports their claim, which support the importance of creating strong knowledge within the QRM community. Throwing risks from other projects at the table could be a good way of supporting their claims, and be heard.

In addition, through interviews and observations it seems not enough work is done in front of meetings and especially workshops. Experts use their tacit knowledge to discuss the risks without any firm data to support their claims. Thereby, the justification relies heavily on what the expert remember at that point of time. The reason for this could be time pressure or lack of willingness to do research upfront, and the process becomes sloppy with a low degree of knowledge involved.

Reflection is a word some of the experienced QRMs used a lot in the interviews. They stated that the project teams are not good enough at stopping to reflect on what is being said and ask question. It is important to challenge the experts and not believe everything they claim. How well have they prepared before the risk session? Do they have data to support their claims? If not, are the activities to reduce

the risk good enough? A project leader stated that we are not good enough at identifying good actions. Could this be the reason? A QRM told that not everyone dared to ask those critical questions and challenge the experts, nor did they reflect on what was actually said.

Adding a knowledge dimension could force the team to reflect on what knowledge is behind the assessment. In addition, the knowledge enablers of creating the right context and managing conversations talked about earlier could prove useful. The right context would encourage and nurture participation, while managing conversations could help people reflect and moderate disputes. However, preparations before workshops and meetings, to refresh their tacit knowledge from old projects and gather new knowledge, should maybe receive more attention.

5.3.3 Building/changing a Prototype

The concepts that are chosen for further development after the justification, is transformed into a prototype. In a risk context, it means a prototype of the risk is implemented or changed in the risk register. It could be a new consequence, probability, action or a completely new risk. Most likely, the team will have a stronger knowledge of the risk at this stage than in the first knowledge creation steps, and by revising the risk through the knowledge creation steps weekly or monthly. Then the team will gain a strengthened knowledge of the risk at each cycle forming a spiral of knowledge that increases by time.

PIMS

Earlier, the need to include a knowledge dimension in PIMS was suggested, but there are more improvements that should be done to better utilize PIMS as a tool within knowledge creation. This section is related with the step of documenting in the enabler: creating the right context. It is about creating a virtual space that enables knowledge creation.

First off, a QRM thinks it is important to define the risks in a good manner so the next time they meet, it is easier to remember what they have talked about. She actually experienced that they did not remember what they had discussed earlier because of bad risk descriptions. She is not sure if everyone are good enough at making good risk descriptions in PIMS, and it seems to be a well-known issue throughout the organization. Everyone interviewed believed it was difficult to understand a risk description that others had made. In addition, sometimes it is done purposely so that the leadership would not understand it properly. There was an example where a risk was addressed as a weight issue in PIMS, but it meant that the whole concept was flawed and had to be rebuilt. The risk went through a DG passing without the decision makers understanding how serious that risk was. It is the QRM's responsibility to ensure quality in risk titles and risk descriptions that everyone understands, even those from the outside of the project team. A good way of ensuring it could be by using the microcommunities of knowledge. Here, risks could be shared, discussed, and reflected on. Members participating in the discussions are outsiders of the project and do not have the context to understand it. Therefore, it would be good way to quality-check the risk descriptions. Poor risk descriptions would be impossible to learn from, and thereby would this knowledge creation process in the risk register falter.

One way of securing knowledge creation in the risk register would be to link documentation from E-Room. Most of the risks in the risk register are well documented in E-Room i.e. with technical details of the situation. Some people are good at linking together information and risks in the risk register to make it easier to find later. However, others do not practice it at all. By adding the knowledge dimension, it could make an increased focus on the task of gathering and linking information to the risk, which will publicly show a stronger knowledge of the risk to decision makers. Using the excel sheet suggested earlier where people can check what type of information has been gathered and linked from

the E-Room. It would help team members reflect on what type of research that could be gathered. By adding relevant contact persons to the risks, and having microcommunities of knowledge who share risk registers and E-Rooms, would further help finding good and relevant information, which in the end leads to a stronger knowledge of the assessed risk.

Another point to discuss is technical and organisational risks. A QRM believed a lot of the organisational risks would be similar from projects to project, i.e. supplier behaviour risks. Putting risks in such categories (organisational risk, supplier risk, technical risk, human risk, etc.) could make the risk register more searchable and easier to learn from.

The last point to address in this section is the closing of risks. Today, a risk is closed without any proper documentation. If the team has time, they would document their experience in PIMS Extra, and maybe upload it to the Experience Transfer Portal. This is usually done at the end of a phase in the project, at project end, or probably never at all. Usually, the risks that are remembered as important at that point of time are documented. If the risk registers are to be used as a source of information for other projects, then every risk should be documented in a better way. First, when an action is closed, did the action actually work? Why did it, or did it not work? Would you recommend this action for other projects? As mentioned earlier, projects struggle to identify good actions that make a difference in the project. Well documented, both good and bad actions could save other projects for a lot of time, i.e. not investigating an action further, because it did not work or turned out bad in another project.

Secondly, when a risk is closed, it should be documented in the risk register if it occurred or not. A risk will probably not be very useful as historical data if we do not know how the risk affected the project, positively (actions worked) or negatively (actions did not work). Therefore, the risk register needs a new function. When a risk is closed, a window should appear requiring the assessor to log if the risk occurred or not, what the consequences were, what the team did wrong, and what they could do better next time. The same could be done with upside risks, telling what the team did right. By doing this, it would help the team to regularly stop and reflect on what has happened in the project. Not stopping to reflect during the project was one of the main issues discussed with some of the more experienced QRMs. They claim the project team is so eager to fix things and do their work, they forget to stop and reflect. Project members dislike too much logging, and they will probably not appreciate the new function if it becomes too time consuming. A QRM spoke of the importance to have regularly meetings, trying to find new elements that could lead to a risk, and write down important experiences in PIMS Experience. “We aren’t good at registration of experience as we go. This is usually done later when we have time, but we know the importance of writing them down regularly.” He tells. This new function could help the team to be better at regularly registration of experience.

Schindler & Eppler (2003) writes that they believe systematic retention of project experiences enables a company to compare its various projects more systematically and document its most effective problem solving mechanisms. In addition, the systematic documentation of mishaps, mistakes or potential pitfalls helps reduce project risks. The end of a project is consequently the end of collective learning. The involved staff moves on to new projects or they are reintegrated into their line function. If their specific knowledge of that project is not directly needed, organizational amnesia begins. Further, Schindler & Eppler (2003) believe a success factor is regularly to capture the most important project experiences directly after important milestones with the entire project. This seems to be true in Statoil and underscores the importance of proper documentation and cross-leveling of knowledge, which leads us to the next section.

5.3.4 Cross-leveling Knowledge

Finally, in this step the team assumes the responsibility for sharing its knowledge with the organization at large.

During Schindler & Eppler's (2003) action studies, they identified the following reasons for project amnesia, i.e., not eliciting and documenting lessons learned. They are all related to four elements, namely time, motivation, discipline, and skills. In those cases where gathering of lessons learned takes place, the gained knowledge is often not edited for reuse, or not accepted as valuable knowledge by others.

Sharing Risk Register

Now that we have created a risk register containing risks with strong knowledge in the previous steps. Experience from good or bad actions, and experience from occurred risks, should be shared with the rest of the organization. How can PIMS be better utilized at globalizing the local knowledge created, and be used by teams in other projects? Earlier chapters brought forth some issues when implementing the prototype to make the risk register easier to share. Even though the risks are implemented in a good way, it does not mean that the cross-leveling challenge is solved. Cross-leveling of knowledge may be the most difficult step of the knowledge creation steps in a large and complex organisation.

Freeze Function

The risk register is dynamic, and changes continuously throughout the project. Risk titles and descriptions may have changed a lot from the point of creation at the start of a phase, until the risk is closed at the end of the phase. Some risks are even brought through the DG, to the next phase. In the new phase, the risk matrix is usually revised to better reflect the consequences. A QRM told that at DG3 they changed the risk matrix, because it is a huge difference of being delayed one year in the planning phase compared to the execution phase. Does the risk register reflect this change when used as experience for another projects? The risks brought through to the next phase may have a completely different meaning, and thereby the title, description and assessment are changed to better reflect the new phase.

When you look at a closed risk register from earlier projects, all you see is the last risk picture. Think of the risk register as a video, documenting a changing and dynamic risk picture throughout a project. What you actually see in PIMS R4 today is the last scene of "the movie". It is not possible to see how the risk picture was in the start of the project, or how it has changed each month. Important information could go missing, and it is even harder to understand the context the risks are in, as you cannot see the risk picture the day they closed the risk. A QRM wishes to see the risk picture in the start of the project. She wonders what risks they started with, and then see how the risk picture develops throughout a project. Do the risks they start with actually work? What type of risks surfaces later on in the project? In addition, it would be a lot easier for the project team to reflect and learn if they could look back and see how their risk picture evolved according to the mistakes they made. It would be possible to implement trending tools to understand and analyse how the risk management process functions throughout the project. In example, it could show how the total consequence of loss develops throughout the project, and answer questions like: Are we good enough at identifying good risks at the start of a project, or do most of the serious risks appear later on? This way, it would be possible to see which projects are "good" and "bad" at risk management, and thereby decide which project one should learn from.

Schindler & Eppler (2003) believe a key success factor is to perform the *lessons learned gathering graphically*, e.g. collecting and structuring the project experiences along a time line (e.g. as a process

map with mistakes, successes, insights etc.) and provide a workshop documentation in a poster format visible for all staff involved.

It is important to see the whole story of the project, how the risk picture has evolved, and therefore suggests adding a timeline to the risk register. One possibility is to add a timeline, showing the risk picture at each milestone in the project.

Another possibility is to bring back the freeze function. This function gives the possibility to freeze and save the risk picture. The project team could then choose their own strategic important dates to freeze and save the risk picture. In a project (Project 1), the function was used monthly at each report to the project leader/AOR. As almost the same QRMs entered a new project (Project 2), they were able to copy the risks that Project 1 had, and use them in the start of the Project 2.

Audio recording possibility where the project team explain the context of the risk picture and their focus at that point of time could be beneficial to add. An audio recording combined with a "click around" database would be an interesting and faster way of sharing knowledge across projects. Especially together with microcommunities of knowledge that would be able to answer questions about the risk register.

A monthly freeze of the risk register or a timeline is critical if the risk register is supposed to be used as a source of information. Today, one and a half project has used the freeze function. To be able to learn from earlier projects who never have used the freeze function, a timeline has to be created. It should be possible as each risk assessment receives a date in the system. However, Omega may have to apply some huge adjustments to the system. Why the freeze function was removed is unknown to me. However, seems those few QRMs who used it in project 1 and project 2 wants it back, as they thought it was useful.

Re-creation of Risk Register

Using another project's risk register as a basis for its own risk register has proven useful in Project 2 by the use of Project 1 as a starting point. However, the QRMs who did this worked in Project 1 and knew the context. The risk register was also frozen at each monthly report. The interviewed agreed it could be useful have a look into another project's risk registers, while some thought it would be dangerous to use the risks, as it is difficult to understand the context. The risk register should be a source of inspiration and not something to copy. Even though you do not know the whole context, each risk is a source of inspiration to be re-created as a new risk in your own risk register to the according context. Investment projects in Statoil consist of such complex events that will never be similar in another project. Therefore, information transferred from other projects should never be copied, and used only as a source of inspiration to trigger knowledge and creativity. It can enable a mental space to create the right context, as written about earlier.

Von Krogh, et al. (2000) agrees in chapter 2.3.5, where they explain the importance of re-creation of knowledge. They write that rather than speaking of knowledge transfer, then, think of it as a process in which knowledge is globalized through re-creation at the local level and not mere imitation. Further, they write that knowledge that is transferred from other parts of the company should be thought of as a source of inspiration and insight for the local business operation, not a direct order that must be followed. This is because some objects has irreproducible features, or could be poorly documented.

Informing the project team of important top ten risks from other projects creates discussions. While a project leader thought the idea of sharing the risk registers between projects was a good suggestion theoretically. However, in practice he barely has time to look at his own risk register.

Experience Transfer Portal

Today, the Experience Transfer Portal is the only searchable database with information about earlier experiences and risks. Experiences from risks are documented locally in the PIMS Experience module. These are only available for project members with access to the domain. If the project team believe the experience could be of use to others, they upload it to the Experience Transfer Portal.

A QRM thought the experiences in the Experience Transfer Portal on the intranet should have risks attached to them. Risks from the risk register would give more information to a QRM, but the problem is that this module is open for everyone in the organisation. It raises a question about confidentiality and sensitivity of the information shared. Many risks could contain crucial information about a supplier. When sorting out the sensitive information, a lot of important experiences are neglected from the Experience Transfer Portal.

This issue constrains the use of the Experience Transfer Portal and supports the need for sharing of risks registers between QRMs. It is still important to document all experiences in the PIMS Experience module even though it contains sensitive data, as one does not need to upload everything to the Experience Transfer Portal. Access to the domain is the same as the risk registers use and could be shared between QRMs in microcommunities of knowledge. Experiences should contain links to relevant risks to provide with useful information about context and actions. It could also contain links to E-rooms where documents describing the situation are stored.

Forum

Another place to share risks or concerns is within community forums. QRM forums are already used to trade information. A suggestion is to create sub-forums within the QRM forum based on technical areas or on microcommunities. Each of the QRMs should be able to subscribe to relevant sub-forums where they could contribute. The subscription should send out a mail or a notification if a question is asked or answered. This would make it easier to communicate and trade information across projects.

Another suggestion is to use more multimedia objects at forums in Statoil. Through a simple function, employees should easily be able to record and post a video at the forum. This gives the possibility of sharing tacit knowledge through time and space. Look at YouTube as an example. Most students today use YouTube as place of learning, because videos are both faster and easier to learn from than books.

CEO of Phonak said: "*You can either read the operating instructions of your new video recorder for one hour, or talk to a colleague for five minutes to find out how it works."* (Von Krogh, et al., 2000)

Red-light learning

What the interviewed mostly talked about was how not to make the same mistakes again.

Julian (2008) writes that focusing reflection and diagnosis on troubled projects at the exclusion of successful projects is a central feature of what is called red-light learning. This can become enculturated as a punitive experience, and they will not learn from what they are actually doing right. They are just asked to keep doing it, without any reflection on it. Learning more from successful projects, and not only avoiding the mistakes of troubled projects is recommended.

Again, the focus is on the risk register. Mostly negative experiences are found here. However, there are some upside risks, and learning from these risks could be a positive experience. One of the most useful experiences in the risk register to learn from is actions that work efficiently. "Creativity isn't the problem," a project leader stated. Further, he said, "The problem is that we don't work well enough with those risks we have. We have too few actions, and not enough time." This leads back to the section about building a prototype, and the need for proper documentation about successful actions.

Knowledge Activists

Another enabler to discuss is the knowledge activist. The discussion will not focus on how the activist should work, but on who is best fit at being a knowledge activist in Statoil to enhance knowledge creation. Von Krogh, et al., (2000) describes a knowledge activist as people who often form microcommunities of knowledge, smooth the way for creating & justifying concepts and building prototype. They are also essential for cross-leveling of knowledge.

Von Krogh, et al., (2000) Suggests corporate R&D center as a catalyst for local knowledge creation, as they can trigger questions related to business activities by using basic research findings as a lever to get into innovation processes at the business level. Another suggestion is that a company's strategists need to be its activists, inducing change throughout an organization and creating commitment to an ideal. They are close to the knowledge vision of the company and can communicate and explain the direction to be pursued by this vision. Some companies have established knowledge-and-technology-transfer units that take responsibility for spreading technologies, best practices and experience throughout the corporation. However, because these units are quite contractor project-oriented, connecting knowledge beyond the project or contract is often unrealistic. Unlike the R&D, they often lack the basic technical knowledge needed to catalyse knowledge creation. It is also possible to assign one member of each microcommunity as a knowledge activist, which gives local acceptance, but would often pursue the interest of its own microcommunity. At the end, Von Krogh, et al., (2000) suggest that the knowledge activist should be a middle elite manager of some sort who would get freedom to move around the company, be informed by local knowledge-creation initiatives, and share ideas back to them. The activist becomes a voice of the local initiatives in the top management discussions of strategy. In addition, he or she helps to facilitate local knowledge-creation. Another possibility is to assign responsibility for knowledge creation to a knowledge-activist team, or a separate department. There are two types of potential knowledge activists in Statoil, and these are the Leading Advisors and the QRMs. (Von Krogh, et al., 2000)

Leading Advisors as Knowledge Activists

Leading Advisors have the perfect position to function as a knowledge activist. They are not driven by any project, and are a support function to all investment projects. Some of their tasks are to improve their disciplines processes and educate personnel in projects about their discipline. They attend quality control and quality assurance activities. In addition, they are a connection between leadership and projects within their discipline. Within cross-leveling of risk knowledge, both Risk Leading Advisor and Quality Leading Advisor can contribute as a knowledge activist in investment projects.

The Quality Leading Advisor already controls the process for experience transfer between projects. We can look at this person as what Von Krogh, et al., (2000) describe as a catalyst of knowledge creation. He or she can travel the organisation and be exposed to a variety of new data, ideas, insights, opportunities, questions and problems that can be used to improve the way the organisation shares knowledge.

The Risk Leading Advisor could also be a catalyst of knowledge creation within risk by focusing on the knowledge in the risk registers and improving the risk management process to create a stronger knowledge. In addition, the Advisor can catalyse knowledge creation by teaching project teams of the importance of strong knowledge in a risk management perspective, to be able to make proper assessments with low uncertainty. In a risk context, the Risk Leading Advisor could also assume the role of a merchant of foresight. This is to affect and communicate company strategies within risk management, being a link between the projects and the leadership. This is to make every QRM microcommunity understand its work in a broader context, and also use what the microcommunities are suggesting as a contribution to company's vision and strategies.

Von Krogh, et al., (2000) suggests a shared map of cooperation, which would show how the knowledge-creation initiatives across a company are connected. This could be the job of an activist to graphical map the experience in Statoil. Mapping knowledge of risk could be a good way to catalyse knowledge creation in Statoil. (Von Krogh, et al., 2000)

QRMs as Knowledge Activists

The QRM would be perfect as a knowledge activist at the lower level, in example in project teams. They could be coordinators of knowledge-creation initiatives by working together with other QRMs connecting local initiatives in different projects. Through extensive communication between QRMs in different projects who may work with similar concepts or prototypes can cross-fertilize one another rather than duplicate work. They can also help bringing together the right people for sharing of tacit knowledge. They could also be catalysts of knowledge creation by being exposed to new data and ideas through microcommunities of knowledge, which can be used as knowledge triggers in their own project.

The QRM Leader's job would also be as a coordinator of knowledge-creation initiatives by coordinating QRM microcommunities of knowledge, bringing together the right people, forming creative communities and helping them share tacit knowledge from within.

The PMO

The QRM's community could also be looked at as some kind of PMO. Julian (2008) describes them as individuals who provide some combination of managerial, administrative, training, consulting, and technical services to projects. Their mission is to improve project management effectiveness, particularly by enabling the acquisition of knowledge from earlier failures and successes. This description fit the role of the QRM in projects. Communication between QRMs in different projects may help with what Julian (2008) calls boundaries practices, which are a means through which lessons learned can be transferred from one project to another. In addition, a boundary object to help this process could be the risk register. Further, QRM microcommunities of knowledge could help with what Julian (2008) calls brokering, to establish connections between communities of practices by introducing elements of one practice into another. The PMO in this context is quite similar to what Von Krogh, et al., (2000) calls a coordinator of knowledge-creation initiatives helping to share knowledge across project boundaries.

The QRM is already responsible for establishing an experience transfer program in the project. Thereby the QRM plays an important role in what Julian calls retrospective and prospective learning practices, which leads to a revised conceptual framework model from a Statoil context Figure 18.

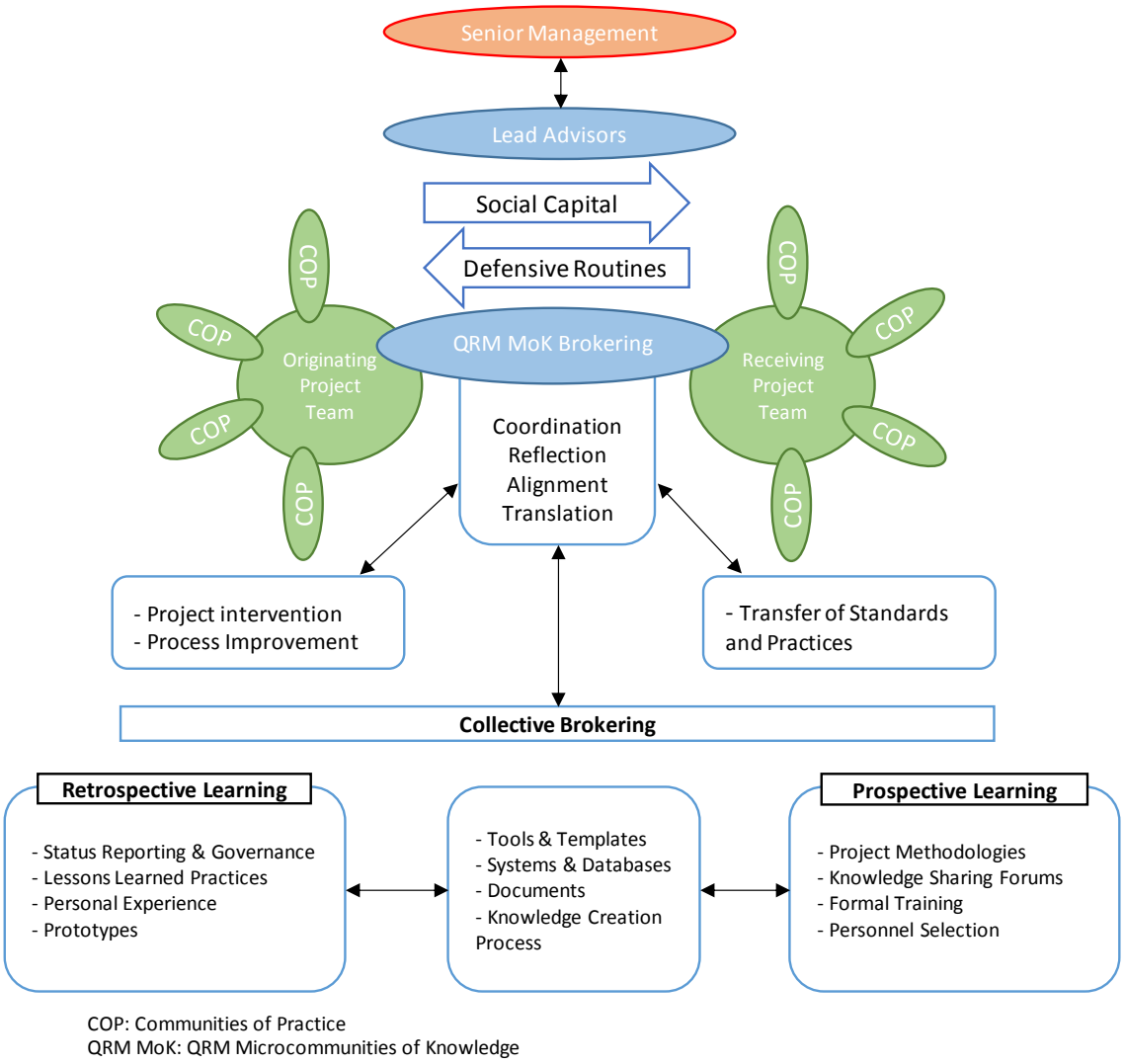

Figure 18: Revised Julian (2008) conceptual framework for cross-project learning in Statoil

Leading Advisors were added to the model as they have the possibility to change or improve the conceptual framework and are the link to the senior management. As a merchant of foresight, they can implement company strategies into the conceptual framework, and communicate contributions from microcommunities of knowledge or communities of practice to the senior management. The Leading Advisor also communicates closely with the QRMs who assume the brokering role.

Utilizing the QRM as a brokering function will hopefully lead to better coordination, reflection, alignment and translation between projects. The QRMs interviewed spoke of a huge misalignment and bad coordination between projects. Every project operates in different ways depending on the project leader and project team. They told of how difficult it was to transfer from one project to another as the new project often had a very different way of working. Collective brokering between projects should be an important issue, finding a best practice that everyone follows. It is not only important in risk management, but in everything done in a project. The QRM has an important role as in ensuring quality in everything done. The coordination of activities is also important as many of the projects use the same suppliers, as we have spoken of earlier.

Prototypes were added to retrospective learning, as the prototypes are experiences made through knowledge creation activities. In addition, the knowledge creation process was added in the middle as

this process gives value to both retrospective and prospective learning through the different steps in the process.

Julian (2008) presents some recommendations to PMO leaders. He believes it is important to focus on accumulating social capital across multiple communities by establishing a network of strong relationships built on trust, professional development, and mutual understanding. He also recommends to focus equal emphasis on learning from successful projects as those that appear to have failed or run off-course. Thirdly, reflection over the course of the project rather than only at project closure is important. The project team may not have recorded learning as the project progressed, and for projects that last years, members will clearly have difficulties remembering the ways in which they solved the problem making the learning generated highly selective and potentially less useful for future teams. At last, he believes a "neutral" and skilled facilitator will give a more productive reflection in lessons-learned sessions. This could help break down the barrier of defensive routines, prevent "blame storming", and help uncover tacit knowledge (Julian, 2008). Schindler & Eppler (2003) also suggests to have and external, neutral moderator in their paper. This supports the idea of educating a few expert QRMs at facilitation who can be used in other projects as an outsider at special events like workshops.

6 DISCUSSION

In this chapter, the analysis will be discussed in a theoretical perspective, looking at how knowledge creation & enabling and risk management fits together. Thereafter, sources of error will be discussed.

6.1 KNOWLEDGE IN RISK MANAGEMENT

I would like to start the discussion by asking; what is knowledge in a risk context? In the case study, it is placed most emphasis on experience transfer and lesson learned, but is it enough when managing risk? Knowledge appears to be an underused term compared to the preceding terms. For me, knowledge in a risk context is not only about lessons learned and experience transfer. These terms are based only on historical data that is impossible to apply in a 1 to 1 scale in a new investment project, as neither the context nor the conditions are similar. There should be a focus on all the factors that increases a person's or a team's knowledge. As an example, Wikipedia describes knowledge as a familiarity, awareness or understanding of someone or something, such as facts, information, descriptions, or skills, which is acquired through experience or education by perceiving, discovering, or learning. Knowledge can refer to a theoretical or practical understanding of a subject. It can be implicit (as with practical skill or expertise) or explicit (as with the theoretical understanding of a subject); it can be more or less formal or systematic (Wikipedia, 2015). This understanding, in addition to justified true belief, supports the argument that knowledge is so much more than historical data. Historical data such as lessons learned should only be used as an inspiration to trigger creativity of peoples mind, extracting the knowledge needed to solve a problem or identify a risk. As John F. Kennedy said:

"Change is the law of life, and those who look only to the past or present are certain to miss the future." [John F. Kennedy 1917-1963, 35th President of the United States]

Throughout the analysis, knowledge seemed to be the basis of everything done in risk identification and assessment. Each action is based on knowledge, or to create a stronger knowledge of the situation. In the case study, this happened automatically without any thought of knowledge as the main priority in the process to be able to identify or assess risks. Everyone interviewed recognized themselves in the knowledge creation process, but had not thought of how they worked as a knowledge creation process in risk management.

6.1.1 The Effect on Risk Management

In a risk perspective, Aven (2013) focus on the knowledge dimension as part of the risk assessment. However, knowledge could be looked at in a broader perspective. According to Von Krogh, et al. (2000), knowledge is based on observations of the world, which in turn depend on a unique viewpoint, personal sensibility, and individual experience. It can involve feelings and belief systems of which one may not be conscious. As observed in the case study, knowledge affects all parts of the risk management process.

Knowledge affects the perception and understanding of risk management

First, it would affect how individuals perceive and understand the concept of risk management and the four basic pillars of the new risk perspective presented by Aven & Krohn (2014). In example for concept of mindfulness, preoccupation with failure depends on the organisations ability to learn from failures through sharing of both tacit and explicit knowledge, and use their own or the project team's common knowledge to be sensitive to signals of failure. Reluctance to simplify may depend on feelings and belief systems of which one may not be conscious. While, sensitivity to operations and commitment to resilience may depend on the individuals tacit knowledge rooted in action, commitment and

involvement in a specific context, to be able to acquire the necessary experience to sense or perceive risks and take necessary actions. In addition, deference to expertise depends on individuals with strong knowledge of the event.

Knowledge affects risk identification

Secondly, knowledge affects how and which risks are identified. In the case study, it depended on what knowledge the project team had at a certain point of time when identifying risks in workshops or meetings. As every risk identification sessions consist of a team of individuals, they need to be able to share their tacit knowledge with each other in order to gain a strong common project team knowledge, which would contribute to identification of risks. In addition, the tacit knowledge has to be triggered. Experiences from years back may have been forgotten, but can be triggered by knowledge enablers like creating the right context or managing conversations. In example, can explicit knowledge from earlier project risks be used to set a context and trigger such knowledge. It could be used as an inspiration for creativity to identify new risks. How and which risks that are identified is strongly connected with the knowledge creation step of creating concepts.

Knowledge affects risk assessment

Knowledge affects how the risks are assessed and what risk reducing measures are implemented. In the case study, this part was closely tied with the method for assessing strength of knowledge, as each of the conditions could be thought of as actions to create a stronger knowledge of the risk by i.e. gathering more data, more experts, and deeper analysis, etc. However, in the case study there will never be enough data, nor time to be able to do proper analysis when assessing the risks. This is because of few, but huge investment projects with many years of lead-time. They are also extremely complex, and the conditions will not be the similar enough that historical data could be directly used. Thereby, the risk assessment in the case study is most dependent on the expert's tacit knowledge to use historical experience as an input to be re-created as new knowledge at the project. This is strongly connected to the steps of justifying concepts and building or changing prototypes.

Risk assessment relies on cross-leveling of knowledge

As observed in the analysis, there is a close relation between the risk management process and the knowledge creation process. For an organisation to improve in the future, they rely heavily on the last step of knowledge creation, cross-leveling of knowledge. Risk management also relies on this step, as without the possibility to cross-level knowledge from project to project. There are no possibilities for the new project teams to learn from previous events, and there are no historical data as input for risk analyses and assessments. This leads to risk management in a project that relies on those few who have actually experienced the events and the consequences of that event. It would probably lead to all projects making the same mistakes, which could have been avoided with cross-leveling of knowledge and proper risk management of the knowledge gained. In the case study, this has been a problem as they have good systems for managing risks. However, because of the lack of good cross-leveling of knowledge, similar surprises compared to the risk picture appears in more than one project.

As knowledge seems to affect the risk management process, there is a need to discuss the knowledge enablers who contribute to strengthening knowledge creation in an organisation.

6.1.2 Knowledge Enablers

Von Krogh, et al. (2000) writes, *"Any attempt to control knowledge creation will end up referring to the explicit historical knowledge that already exists. This kind of knowledge rarely sparks the innovations and enabling context required to develop future advantages of a company."*

Knowledge cannot be managed and therefore needs enablers. In risk management, we wish to not only refer to explicit historical knowledge, but also spark innovation to identify surprises compared to the explicit historical knowledge. A few knowledge enablers have been analysed in the case study, which seem to fit quite well and could increase the project team's knowledge of risks. However, it has to be tested in practice and be quantified through studies before having any firm proof if it would work in Statoil. Let us discuss each of the enablers tested in the case study.

Enabler 1: Instill a Knowledge Vision

Instill a knowledge vision was not analysed as it requires to look at the organisation as a whole, which was outside of this thesis' limitations.

Enabler 2: Managing Conversations

Management of conversations are important in the risk management process as it helps the project team to share and create tacit knowledge. As the project team shares tacit knowledge with each other in meetings and workshops, they build a stronger common tacit knowledge that can be utilized to improve the risk identification and assessment. By using the principles for managing a conversation, it would be easier for every member to participate; even the quiet ones, who may have valuable tacit knowledge or "silly" questions. These questions may trigger the expert's knowledge to be able to identify new risks. These type of questions seemed to be very helpful for the risk management process in the case study. In addition, the management of conversations will affect the justification of concepts and help experts to establish a good factual discussion through properly edited conversations. It will also help them easier reach a common understanding and thereby an agreement on the phenomena through justifications of the risk. Further, it will help the project team reflect by asking the "correct" questions. Reflection would make the project team stop and think in order to give meaning to the risk that is being assessed. It was noted in the case study that through reflection, the process would not be rushed and it would lead to a more proper assessment.

Enabler 3: Mobilize Knowledge Activists

Mobilizing knowledge activists would help the risk management process by catalysing and coordinating the process of knowledge creation and risk management. It would be the brain behind all knowledge enablers and knowledge creation steps to make them work. The merchant of foresight affects the company's vision to focus on knowledge enabling and risk management, and affect the organisation by implementing tools and strategies to the risk management process. The catalyst could manage conversations and create the right context. They could travel the organisation and be exposed to new data, ideas, insights, etc. and formulate process triggers. These process triggers could be used through facilitation of risk meetings and workshops to help create an enabling context and to manage conversations. These new data and ideas could be risks from other projects, used as a trigger for creativity in another project. The coordinators of knowledge-creation initiatives help globalizing local knowledge. They would make data, experts, and knowledge about risks available for the project teams, and it would be easier to transfer knowledge of events between projects through Julian's (2008) conceptual framework. In the analysis, it was learned that the organisation needs special individuals for such a position, and they were found in the case study. They already had the perfect role to take the responsibilities as a knowledge activist. However, some organisations may have to create new roles to be able to mobilize a proper knowledge activist, and if applied in a wrong way, it could be counterproductive. Without the proper understanding and knowledge, they could break down the knowledge enablers, rather than building them up.

Enabler 4: Create the Right Context

Creating the right context affects risk management by creating a shared ideal space for sharing of tacit knowledge, creating concepts of risk, justifying concepts of risk, building of prototypes, and cross-leveling knowledge of risks. This space could be physical, virtual, mental, or all three, and is based on the knowledge spiral of originating, conversing, documenting and internalizing.

The physical space benefits risk management through originating and conversing. In example is, risk meetings, risk workshops, and microcommunity meetings physical spaces to meet and share knowledge. In the case study, it was about having a meeting place to share tacit knowledge and to help individuals concentrate on the task. Meeting rooms could be a typical physical space, but also the coffee shop. It is about creating different places to help individuals sharing knowledge of risk, and doing it face-to-face.

The virtual space benefits risk management through documenting, and the possibility of using computers and software to store and transfer knowledge. In the case study, the risk register and Experience Transfer Portal was such tools that create a virtual space for sharing of explicit knowledge. The virtual space also helps setting a context when building a prototype of a risk as you could implement information of the risk into a graphical solution. This could help analyse or make you see connections that you would never notice through the physical or mental space. The virtual space could also assist with communication through video conference etc. This gives the possibility to communicate across physical space to extract tacit knowledge from experts.

The mental space helps risk management through internalizing and originating. As observed in the case study, limitations and goals were used in risk sessions to help easier understand explicit knowledge to make it tacit once again, and to help extract and share tacit knowledge. The mental context could help creativity in the team by use of in example old risks from other projects as a triggering effect for tacit knowledge. It could also be used to apply different set of rules when justifying concepts, making everyone participate and forcing factual argumentation of the risks.

Under the heading “creating the right context” in the analysis, it has mostly been focused on the mental space, but as you can see. Creating a context is so much more, and each of the aspects affects risk management. Risk management needs a combination of all three spaces or “ba”, and a focus to make them interact in such a way that it improves the risk management understanding in the project team.

Enabler 5: Globalize Local Knowledge

The last enabler is to globalize local knowledge. This enabler affects all available data, experiences and lessons learned to be used as input when managing risk. Von Krogh, et al. (2000) writes that it emphasizes breaking down physical, cultural, organisational, and managerial barriers that often prevent effective knowledge transfer in a multinational corporation. It should be an important factor to focus on if a company are to improve their risk management process. Without this enabler, the organisation will struggle to learn from their risk management process. The case study consists of a multinational corporation, and they struggle to learn from their mistakes. A company could be excellent at risk management, but surprises and unexpected events always occur, and without proper methods to make the knowledge of the events available to future risk management. Then similar events will be a surprise to future projects as well. Risk management relies heavily on historical data to prevent events from reoccurring, and expert personnel to foresee the future. However, without enablers for cross-leveling of knowledge, there will be a lack of historical data as input and the risk management process would be limited. As an example could Julian’s (2008) conceptual framework for cross-project learning be a part of the enabler to help globalize local knowledge. It seems to fit the risk

management process in the case study quite well, and helps break down the managerial barriers between projects. Together with microcommunities of knowledge as a catalyst, it could enable coordination, reflection, alignment and translation when transferring important historical data and knowledge across project boundaries. Combining the theory of Von Krogh, et al. (2000), Julian (2008), and Aven & Krohn (2014) could be a great way to cross-level knowledge in the case study to increase the effect of risk management, as it seems to be depended on the projects ability to move knowledge from one context and re-create it into a new context in another project.

Summary

Through this discussion and the case study, we can argument that knowledge already plays a huge part in risk management. Knowledge seems in the case study to affect the risk management process in every way, and most of the knowledge enablers are already in place. However, the organisation is not aware of the knowledge enablers and do not have a focus or reflection on them. More focus on these enablers in an organisation would improve risk management, as they already play a part in the case study without the organisation being conscious of it. There is definitely room for improvements at this area and it will most likely have a huge impact on the risk management process.

This discussion ends with stating that it seems to be a clear relationship between knowledge creation & enabling and risk management. However, there are some sources of error that must be taken into consideration before concluding.

6.2 Sources of Error

First off, those who were interviewed spoke of what is interesting to them at that point of time, and may speak of something completely different a year from now. As there were no specific questions, they could speak quite freely of things that was interesting to them at that point of time and may have been affected by things they have read or heard just before the interview. However, it was done this way as I did not know how they worked or what their concerns were, and could thereby not specify the questions.

Secondly, only one project leader was interviewed. Another project leader was supposed to be interviewed, but he did not have the possibility to meet me. This creates a one sided perspective when it comes to the project leader's view, which must be taken into account before concluding. It was done this way as the thesis needed another point of view than only the QRM's view. In addition are project leaders very busy and only one of them was able to attend.

This is a single case study and Statoil is the only company included. It limits the evidence in the thesis, as it would possibly not be the same conditions in another company. The reason for it is limitations of the thesis, and it could be something for further research to replicate the methods used here in another company.

In addition, be aware that the analysis and discussion contains some anecdotal evidence based on a limited population sample. It has only been performed ten interviews where many of them spoke of different subjects that concerned them. This was done due to limited time and limitations in the thesis, and there should be done further research to gain a large population sample and quantify it to prove if the anecdotal evidence and hypothesis is correct.

7 CONCLUSION

This chapter concludes the research, analysis and discussion. The conclusion is divided into three sections. The first section concludes the theoretical contribution, while the second section summarizes the expected benefits for Statoil. The third section is suggestions for further research.

7.1 THEORETICAL CONCLUSION

The primary research question of the thesis is; "how can the knowledge dimension improve our understanding of risk management?"

This is a complex question, as risk management and knowledge are huge subjects and the thesis has only been able to look at a few aspects binding them together. Aven (2013) has already tied a connection between the knowledge dimension and risk assessments. However, knowledge can be looked at in a broader perspective. Through a knowledge creation process in chapter 5.3, it seems knowledge do not only affect the risk assessment of the assigned consequences and uncertainties, but it also affects the viewpoints of the project team and how risk management is perceived. To improve the understanding of risk management, one must strengthen every aspect of knowledge that affects risk management. This is not simply done by managing a knowledge creation process. Knowledge creation is fragile and it cannot be controlled through processes, but has to be enabled. Knowledge enabling activities in the case study seems helpful to be able to increase the project team's understanding of risk. Four enablers was analysed to catalyse a knowledge creation process to give stronger knowledge in a risk context. The case study demonstrated that knowledge enablers already are a part of the risk management process. However, the organisation was not conscious of it, and a larger focus on it may improve their risk management process.

Manage conversations benefits risk management by emphasizing an individual's ability to share tacit knowledge with the project team to create a stronger common understanding risk. This could lead to assumptions that are more reasonable and an agreement or consensus among experts, as everyone's tacit knowledge is shared and understood by the team.

Mobilize knowledge activists benefits risk management by making it possible to share explicit and tacit knowledge across time and space in an organisation through coordination. They can catalyse knowledge creation initiatives and ensure a continuous improvement in the organisation's risk management by improving processes and tools. They can also be a catalyst in other knowledge enablers.

Create the right context benefits risk management by creating the ideal space for risk management in the organisation. It could be physical, virtual or mental. The physical context affects where and when the risk management process occurs, while the virtual context affects the risk process through software. In addition, the mental context affects the risk management process through goals, limitations, etc. Good goals and limiting the area that is to be focused on at each meeting was helpful in the case study in both risk identification and risk assessment, as knowledge was shared, created and justified in a better way. A proper context changes from situation to situation, and it is important to be mindful of it. In a risk identification session, the context should emphasize creativity in the team to be able to identify surprises, while in a risk assessment it should emphasize concrete information and factual arguments.

Globalize local knowledge benefits risk management by ensuring enough reliable data as input to the risk management process. Without a focus on it, barriers between projects will prevent them from

learning from each other and the risk management assessment will lack data to make a proper risk assessment. In the case study, there were strong barriers between projects and a lack knowledge transfer, which leads to risk assessments containing mostly tacit knowledge from the experts attending. Further, this leads to weak knowledge of the risk and a high degree of uncertainty. A conceptual framework is suggested to break barriers between projects and ensure a continuously flow of knowledge making assessments more reliable.

In practice, the enablers would act differently from organisation to organisation depending on the environment and organisational structure. The next section presents a few practical recommendations for Statoil that surfaced throughout the analysis.

7.2 PRACTICAL CONCLUSION

Today, Statoil focus on lessons learned and experience transfer, while the term knowledge is not mentioned. Lessons learned is only based on historical data, trying not to make the same mistake twice, while knowledge is the combination of everything perceived in the world. Risk management should not be based only on historical experience or data, but on strong knowledge in combination with creativity to perceive the future. In the analysis, a knowledge creation process was made to illustrate each step in relation to the risk management process. Within each step, knowledge enablers where used in addition to suggestions for improvements in Statoil. This section will now summarize these suggestions.

Risk register

In Statoil, knowledge creation of risk could be centralised on the risk register as a virtual space. The benefit is that the risk management process is already centralised on the risk register, and the knowledge creation process fits well with each step. However, the analysis indicates that the PIMS Risk Module struggles in the last step of knowledge creation, cross-leveling of knowledge. In addition, the Experience Transfer Portal neglects sensitive information, which makes it even a greater benefit to make PIMS data available for new projects. PIMS needs new functions to better reflect the context of the risks, and make the information shareable with other projects.

Assessment of Knowledge

As part of the justification of concepts, Aven's (2013) knowledge dimension could be included in the risk assessment. The benefit is to place a greater emphasis on the knowledge aspect and to inform the decision maker of what the uncertainties behind the assessments are.

Risk Register Timeline

Timelines in the risk register could be implemented as risk register's risk pictures are dynamic and changes over time. The benefit is that it would make the risk register able to present the context of the risks at a certain point of time through a snapshot of the risk picture. It would also give the possibility for trending analyses of the risk picture, and a possibility for the project team to reflect on their project.

Occurred Risks

It would be beneficial to register if a risk has occurred or not, as it could be important information for the new project team. Registration if an action has a positive or negative effect on the risk would also be beneficial. If one do not know if a risk has occurred or not, it would be difficult to learn from the risk and its actions, as the assessment may have been wrong.

Furthermore, there is a need for enablers to globalise local knowledge from risk registers across projects.

Knowledge activist

Knowledge activists could be used to improve cross-leveling of knowledge across projects. The QRM could assume such a role, being a broker between projects to break boundaries by creating coordination, alignment, reflection, and translation. To assume the role of the knowledge activist, they should improve their facilitation skills and have the right interpersonal skills. The benefits are a QRM role who catalyses all knowledge enablers, and could become an important role to ensure knowledge creation and sharing through brokering between project teams by the use of microcommunities.

QRM Microcommunities of Knowledge

By dividing the QRM community into groups of five to seven people, then Statoil will gain the benefit of microcommunities of knowledge. These communities would improve the possibility for sharing of tacit knowledge between QRMs within a technical discipline. It would also help binding different projects together by breaking boundaries between them. Together, the microcommunities could become a knowledge activist, catalysing and coordinating knowledge throughout the organisation.

Re-Creation of Knowledge

The knowledge enabler: globalizing local knowledge emphasizes re-creation of knowledge rather than copying it. Data from risk registers, Experience Transfer Portal, etc. should only be used as a source of inspiration to re-create new knowledge within their project. In addition, there should be more reflection on red-light learning and a focus on using positive experiences. The benefit is the possibility to use knowledge to predict future events, rather than the possibility of getting lost trying to prevent events that happened in another project, context, and environment, which may never fit your own project's context in a 1 to 1 scale.

This thesis is the starting point for future work, to implement knowledge as an important aspect in risk management. It has only been discussed and concluded on why knowledge is important in a risk context, and benefits by implementing such a process with its enablers. There are a lot of possibilities for improvements in the area, which would benefit Statoil. This thesis' most important contribution is to be a starting point for further research and to create a new focus area in the organisation. After discussions with Leading Advisor for Risk Management throughout the last months, some of the suggestions have already been set in motion.

7.3 Suggestions for Further Research

Theoretical Suggestions

- Test hypothesises quantitatively and qualitatively to ensure firmer evidence that knowledge is an important factor in risk management, as this thesis is based on a limited population sample.
- Replicate the studies in another company to ensure firmer evidence that knowledge is an important factor in risk management.

Practical Suggestions for Statoil

- Investigate the QRM role to find what type of personalities and skills that fit this role.
- Streamline the knowledge creation process with knowledge enablers by investigating each step closer, creating procedures, checklists etc.
- Investigate how to create the right context in each of the knowledge steps in different situations like meetings, workshops, microcommunities, etc.
- Investigate how to better facilitate and manage conversations as a QRM in projects, and how to manage conversations at each of the knowledge creation steps in different situations like meetings, workshops, microcommunities, etc.
- Investigate the risk register, to find the best way of adding a timeline and what type trending methods to use.
- Investigate how to instill a knowledge vision, promoting knowledge creation in the company.
- Test suggestions in practice, and monitor over a period of time to ensure if there are any benefits.

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