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Pilots on the Norwegian continental shelf; from a contractual, and a decision making standpoint

Master thesis, The University of Stavanger, Industrial economics

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30.06.2011

“An investment in knowledge always pays the best interest”

Benjamin Franklin (1706-1790)

Abstract

This thesis consists of two different parts which investigates two different things, but with the same topicality in focus. The superior aim of the thesis is to enlighten potential project stoppers with regards to technology development on the Norwegian continental shelf. This is done by investigating the balance between input and output in three different pilot project contracts in the first part, while the second part investigates potential problems related to decision strategies in the operating companies, both with regards to internal conditions and external regulations. To retain information on the latter, two different operators have answered a questionnaire. The investigation has been done in light of the increased number of pilots reported delayed or postponed to the Norwegian government during recent years. The development of enhanced technology is vital to secure increased recovery rate on the Norwegian shelf in a time where many fields are either in, or approaching tail production.

The information extracted from the comparison of the contracts seems to point in the direction that logically enough increased risk consumption and majority towards funding percentage leads to better contractual terms with regards to ownership of technology developed within the contract. The result also reveals that different operators might use different contractual terms, but this might also be due to the maturity of the technology being tested. It is further believed that contractors should be careful of claiming too many rights towards ownership of the technology and also denying paying license fees, if the technology initially has been developed by contractor. This should be taken into account regardless of if the operator finds themselves in a position of superior bargaining power. Such a situation might lead contractors to see technology development as less profitable and therefore decrease their willingness to invest in such developments. If this occurs, the operators will lose an important source towards enhanced technology. Furthermore the contracts do not seem to take into account the contractors' costs due to development prior to the contractual agreement. Such developments can be costly and time consuming, as shown by example in the text. To what degree this is considered by the contracts is however not easy to investigate fully, without access to contractors' profit margins within the specific contracts.

Decision strategies with regards to technology development are examined by answers towards a questionnaire. The questionnaire has been answered by two different operators. The answers, among other things, reveal that human capabilities and personality in form of company "champions" might have a significant impact on decisions towards development/pilot projects. According to the questionnaire operators does not regard ownership to the technology being developed as very important, and states that the right to use the products is an area they focus much more on, in

comparison. Furthermore it is revealed that operators to a large extent use net present value calculations as part of their decision basis, and that they in general would like to see profits from their investments within a two year period. As net present value calculations favor profits in the near future, this can to some extent point towards a rather short time horizon with regards to investments. The oil companies also reveal that they preferably would like to defend investments in new technology on a specific license alone, but also state that effect on multiple fields are taken into account, where necessary. Profitability calculations on multiple fields they however state to be more difficult and thus can be interpreted to be, if not a project stopper, at least an obstacle on the way to initiation of a project.

Furthermore the oil companies have rejected two potential problems suggested by the thesis to be of problematic importance towards development/pilot projects. These are the voting rules within the licenses and the free-passenger problem.

Preface

As a master student at the University of Stavanger it is required that you as a part of the master's degree in Industrial economics, write a thesis of 30 credits. My master specialization has been contract administration, whilst the engineering indentation has been risk management. Writing my thesis in cooperation with a contractor was a great way for me to learn more about contract structure and regulations within the petroleum sector, and furthermore learn more about how main obstacles in development/pilot contract negotiations are handled. The work has also provided me with increased understanding of how project decisions are made and what such decisions are based upon.

The work has been hard at times, since both contractual agreements and decision strategies are mainly within the circumference of confidential information. Alongside with a demand for confidentiality of contractor provided information, this has made some of the writing difficult. I have struggled somewhat to make the text understandable and at the same time keep demands for confidentiality intact. I have however tried to refer all relevant facts to the extent made possible by the confidentiality agreement. Because of the confidentiality agreement, retrieving information from the oil companies also proved somewhat difficult, even though I promised them that the company names would not be revealed in the text. Two operators however came through with answers in the end.

I would like to thank those who have contributed to the writing of the thesis. I would like to thank Petter Osmundsen at the University of Stavanger for guidance and advice, and also the idea towards subject. I would also like to thank my two contact persons at the coadjutant contractor company, for finding the time to provide me with relevant input, guide me in the right direction and spending valuable time contributing to improve my thesis between busy schedules. I am also very grateful to my contact persons in the operating companies for taking the time to answer my questions, and provide me with valuable information.

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Key definitions and acronyms used

COC: Conditions of contract

IOR: Improved oil recovery

IP: Intellectual property

NCS: The Norwegian Continental Shelf

Negative incentives: Negative incentives are in this thesis to be understood as all penalties related to breach of contract terms or individual performance. Negative incentives include increased costs, fines and loss of future contracts and jobs.

NF: Norwegian Fabrication Contract

NI: Norwegian Industry

NKT: Norwegian Total Contract

Norwegian Industry: Norwegian Industry organizes approximately 2200 businesses with approximately 125.000 employees all over Norway. The member's interests are Norwegian Industry's most important task. Norwegian Industry is therefore strongly engaged in the most central industry- and business policies of interest today (www.norskindustri.no).

Petoro: Petoro is the licensee for the Norwegian governments' extraction concessions, fields, pipelines and petroleum onshore installations. Petoro is sorted under the Norwegian oil- and energy department and has been given three main tasks:

- Safeguarding the Norwegian governments' interests in shares where the government is owner
- Monitoring of Statoil's allocation of the petroleum produced by the governments' direct shares in accordance with the instructions given to Statoil
- Economic administration and accountancy of the governments' direct shares within petroleum

Positive incentives: Positive incentives are in this thesis to be understood as all bonuses related to achieving pre-determined goals. This includes faster production and progress, cost savings, promises of future contracts/jobs, individual and company performance.

Risk premium: Risk premium is defined as the amount of uncertain benefits a company or an individual is willing to forsake, in return for certain, but smaller benefit.

The Extraction Committee: The Extraction committee consisted of 10 members with different background who was appointed by the Norwegian government to map the situation and suggest actions towards increased recovery from existing fields on the NCS.

1. Introduction

1.1 Background

1.1.1 Historic

During the late 60's, when oil and gas first was discovered on the Norwegian continental shelf, Norway were in many aspects an undeveloped country with regards to technical competence within this sector. Central people within the Norwegian government saw it as a disadvantage to the domestic economy if all development tasks of the fields were awarded to foreign companies, even though they had better experience and knowledge. To give monopoly to a single company with regards to oil recovery had already been tried in Denmark[1] (Nebben & Ask, 2009), and Norwegian officials did not see this as an ideal situation on the Norwegian shelf. Politicians therefore made it a priority to collect information, know-how and expertise to the Norwegian industry so that they could build up their competence, and eventually build up their own oil and gas - infrastructure. This resulted in contracts with suppliers that aimed to fulfill this need for knowledge and technology.

This strategy proved to be wise, and today Norway is by many seen as a leading country when it comes to research and development within the petroleum sector, maybe especially within offshore activity. This is underlined by statistics showing that average global recovery rate for oil is 22% while average recovery rate for oil on the Norwegian shelf is 46%[2] (Åm et al. 2010, p. 16). Some of the differences might occur due to reservoir dynamics, recovery strategy, size of the field and choice of production system (for example stationery rig, subsea system or FPSO[3]), but when looking at statistics from the early nineties and up until 2010 it is clear that the increase in recovery rate on the Norwegian shelf has been dependent on implementation of new technology (Åm et al. 2010, p 18). These technologies, among others, include development of methods such as extended use of water/ gas injection and the drilling of horizontal wells.

To achieve such progress innovative people have been dependent on the oil companies to show liberalism, open-mindedness, funding and willingness to take on risk, as pilot tests and development of ideas has taken place. While new technology was driven forward by operators with large projects in the early days of the Norwegian petroleum production, fields and projects are now becoming

[1] A.P. Møller was given exclusive rights to recover oil on Danish shelf in 1962.
[2] In 1995 the expected average recovery rate on the NCS was 40%, this percentage has risen to todays 46% as technological development has taken place (Facts 2010 the Norwegian petroleum sector, 2010, p.38).
[3] FPSO: Floating production and storage system.

smaller and technology can not necessarily be funded on a single field development alone. This means that development of technology in the future, to a larger extent, will be dependent on cooperation across licenses and between supplier companies and operating companies (Åm et al. 2010, p. 45).

1.1.2 Status on the Norwegian shelf today

Today the situation on the Norwegian shelf is that the oil production has a decreasing tendency, after a peak in production around year 2001 as shown by *figure 1* beneath (recent findings, such as *Skrugard* (Ree & Helgesen 2011), are not taken into account). As the figure indicates, the oil production on the Norwegian shelf is almost down to half the volume of 2001. The gas production is still increasing, but due to severe differences in price between oil and gas, the increase in this area is not able to compensate for the decrease in oil production. Due to high oil prices, revenues from the Norwegian shelf still remain high at the time this thesis is written (see *figure 2*).

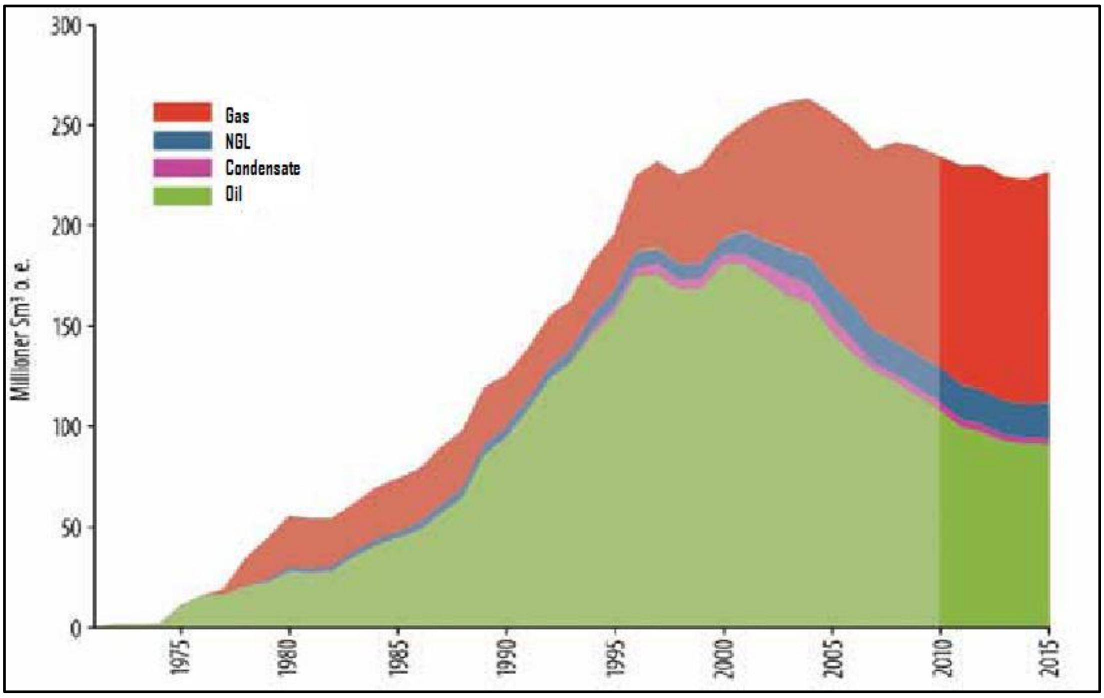

Figure 1: Historic and forecasted production on the Norwegian continental shelf (the Norwegian Petroleum Directorate [NPD] 2010)[4]

[4] The figure shows million Sm³ of oil equivalents produced on the vertical axis, and the respective year on the horizontal axis.

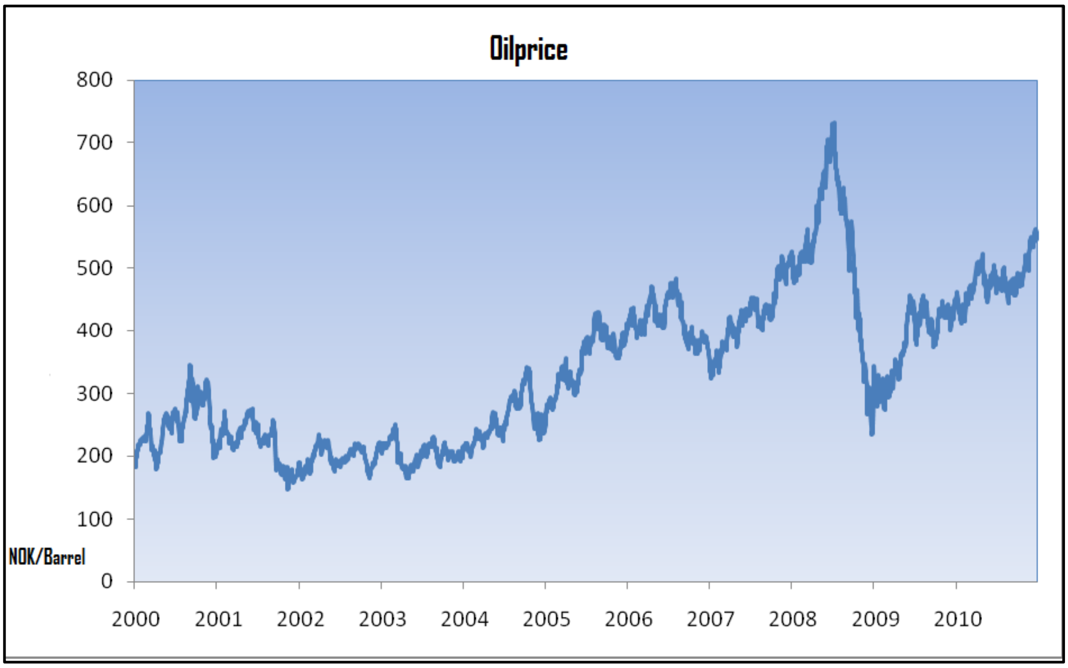

Figure 2: Oil prices in NOKs versus respective year

(U.S. Energy Information Administration referred by Norwegian Tax authorities, 2011)

1.1.3. Time criticality and potential upside of new technology

Remaining resources in existing fields are as previously mentioned, comprehensive, but is technically challenging and demands big investments both in finance and labor. On the bright side the existing fields already have numerous wells in place and an infrastructure to manage the production. On the other side many of these fields are in tail production, so measures to increase recovery here are time critical. To illustrate the time criticality Petoro CEO, Kjell Pedersen (2011) made this statement when asked about the remaining resources in mature fields on the Norwegian shelf:

"*To get this up, there has to be drilled two to three times as many production wells on a yearly basis, increase focus on new and easier ways to develop fields, and new injection methods has to be put in to use to squeeze more oil out of the reservoirs. This demands large investments and these investment decisions have to be taken within five years or it will be too late".*

Should production cease to be cost effective and lead to closure of the fields before new technology can be tested, it would probably require a pilot with a massive upside potential before the operators would consider opening up an already closed field. The reason is that opening up an already closed field requires big investment costs (cost often depends on length of time since demobilization), and that if the pressure in the reservoir drops to far down it is near impossible to reopen[5].

In the ten biggest reservoirs on the Norwegian shelf today average recovery rate for all petroleum resources vary from 29 to 66%. If this was raised to an average of 70% it would equal to new Ekofisk-fields [6](Åm et al. 2010, p. 17). An increase in recovery rate of just one percent would have a potential value of 270 billion NOK[7]. The extraction commission argues that a substantial amount of these resources can be produced with better external conditions and implementation of new technology (Åm et al. 2010, p. 17).

To illustrate this they have worked out two models which have to be seen in comparison to one another to unveil their meaning. *Figure 4* shows four different opportunity sets which varies with oil price and costs, and also with the amount of effort given to development of new technology. The four different outcomes are then sketched into *figure 3*, the projected production profile for the Norwegian shelf. As the figure illustrates the different outcomes proposes a substantial difference.

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[5] Second time production have never been done previously on the NCS. The possible exception is the Yme field, which was operated by Statoil from 1996 to 2001. This field is scheduled for reopening by Total during the fourth quarter of 2011 (Haugstad, 2011).
[6] Recoverable resources on Ekofisk are estimated to 530 Mill. Sm³
[7] Based on the following key values: oil price 70 USD per barrel, 1 USD = 5,5 NOK

While opportunity set three would reach the Norwegian oil and energy departments' vision[8], opportunity set two would implicate that even recorded resources would not be recovered. It is easy to see future investments in technology in accordance with the oil price and the costs to actually operate in the market, but as *figure 3* illustrates, a strong focus on technology and development together with low oil price and high operating costs (opportunity set 4), will actually yield a higher and more favorable production profile than a situation with high oil prices, low operating costs and a weak focus on technology and implementation (opportunity set 1). Even though the potential upside from new technology seems to hold massive value, the Norwegian authorities is receiving reports from the companies that many pilots that could help improve the situation, are either postponed or delayed.

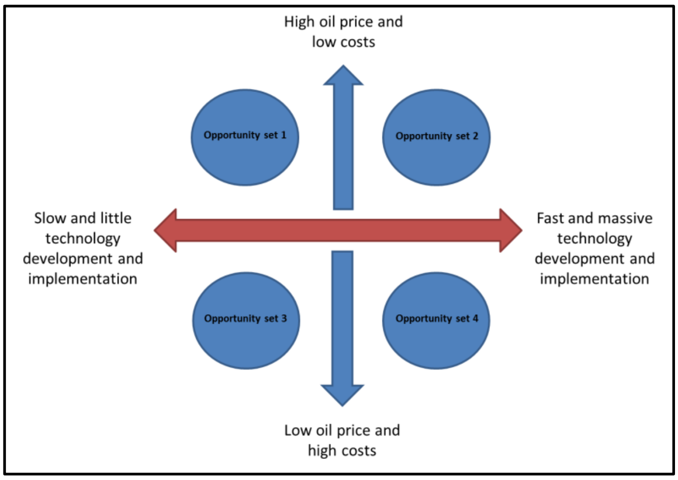

Figure 4: Different scenarios for the Norwegian shelf as a function of oil prices/costs and development and implementation of technology (Åm et al. 2010, p. 19).

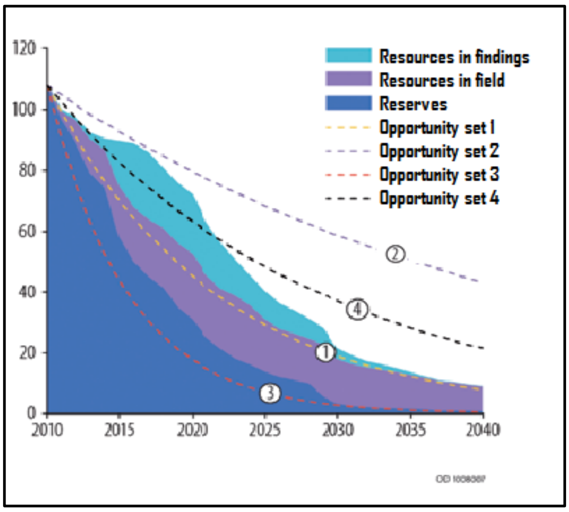

Figure 3: Production profile for oil that shows the predicted production as a function of the different opportunity sets (Åm et al. 2010, p. 19).

[8] The vision is that 2,5 billion Sm³ extra oil can be recovered from the Norwegian continental shelf with the use of technology (known and new) (Åm et al. 2010, p. 18-19).

1.1.4 Definition of pilots and pilot projects?

The word *pilot* has many meanings, but when looking it up as an adjective in an encyclopedia, which is the meaning I will focus on in this thesis, it yields the following definition: "*serving as a guiding or tracing device, an activating or auxiliary unit, or a trial apparatus or operation <a ∼ study>"* (Britannica academic edition, 2011).

An alternate definition is written in a dictionary: "*Pilot is used to describe something, such as a scheme or a project, which is done as a test on a small scale in order to see whether it will be successful*" (Clue, 2011)

The second definition above is not entirely correct since there are examples of pilots in the oil and gas industry that has been built on a full scale prior to implementation. To define pilots as small scale is therefore inaccurate.

Based upon these definitions it is in my opinion possible to conclude that a pilot is an object[9] or an intellectual achievement[10] done as a test to see whether it will be successful or not. Pilots are used in many businesses but this thesis will only focus on pilots within the oil and gas sector. These pilots are often tested on a subset of the general intended system and/or against artificial created forces before they based on the successfulness in the tests are implemented, or put to use.

These definitions of *a pilot* lead on to the definition of a *pilot project* which is a word that is not defined in many encyclopedias or dictionaries. From the definitions of a pilot above, it is however possible to apply logical reasoning and define a pilot project as *an activity performed as a test or trial.*

[9] For example structures or machinery built to solve a specific problem.
[10] For example movie pilots, TV pilots, academic pilot surveys and technical solutions

1.1.5 Why make pilots?

New technology is today needed on the NCS to extract potentially profitable reserves. To get new technology implemented, pilot testing are in many cases crucial. A pilot can especially give information about important factors such as technical challenges, profitability potential and operational regularity. Examples of technical challenges may be interface with the already working system, locating vulnerable areas and information with regards to reaction of breakdown of one or more vital parts. The profitability potential is also closer established since many effects are difficult to map by theoretical calculations alone. Operational regularity is especially important to map with regards to subsea development. Due to the submerged placement of the production system, intervention is costly and often requires rental of a rig. Rigs are, at the time this is written, scarce and often very expensive to rent (Ree, 2010). This in turn means that mapping the operational regularity also has an impact on the profitability potential.

1.1.6 Purpose and problem to be addressed

As I have briefly explained in the previous sections, a large amount of resources today remain in the ground after the fields have been demobilized. One of the reasons as to why this is happening is the strong cost discipline which characterizes many of the oil companies. At the same time the Norwegian government is receiving information that many pilots, that could help improve the situation, is either delayed or postponed. Many fields on the Norwegian shelf is also maturing and starting to enter tail production. These fields also have a strong need for new technology, so that they don't have to shut down prematurely.

In the first part of this thesis I will look at incentives and contract theory, and how they are applied in pilot contracts on the NCS. This will be done by investigating how the contracts relate to the parties' input factor on the one hand, and profits on the other. To map input and outputs, I will be analyzing key elements in the contracts such as ownership, right of use, finance, economical profit and rights to technology. This will hopefully be valuable in understanding more of the incentives and drivers the different sides relate to when developing and implementing new technology. This in turn will hopefully provide information of how balanced the terms are, and if the potential unbalance can be seen as an obstacle towards development/pilot projects.

In the second part I have sent out questionnaires to different operating companies. The questions in the questionnaire relate to what they base their decisions on with regards to pilot projects, and also how the company structure and internal incentive schemes may influence decisions regarding pilot projects.

The two parts together will hopefully help me map some potential pilot project stoppers, in regards to the co-operation between operator and contractor to succeed in development of new technology. It will also help to clarify if less than optimal consequences may arise, with regards to pilots, due to internal arrangements within the oil companies or external regulations. This will in turn hopefully help to understand why so many pilots are reported delayed or postponed, and also if there are reasons within the contract agreements or decision strategies that contributes to prevent such projects.

1.1.7 Circumference and demarcation

This thesis investigates conditions for pilot projects in the oil and gas industry on the Norwegian continental shelf today. Conditions for pilots previous to today's situation will only be mentioned briefly. Conditions for pilot projects in other countries and other businesses will not be discussed.

The basis of the thesis is a questionnaire answered by two different operating companies, three pilot contracts made available by a coadjutant contractor, and also other material made available by this contractor. The two operating companies constitute a group that controls a large portion of the active fields on the NCS today. The contractor is also a major participant on the Norwegian shelf.

2. Theoretical basis

2.1 Contract theory

I will in the following section try to explain general contract and incentive theory[11]. The literature used is to a large extent based upon subjects in contract management I have taken throughout my degree. The contract theory does not discuss juridical questions, but seeks to explain the economic and strategic standpoints that are considered in most rational contract negotiations. The purpose of this section is to better equip the reader to understand the strategies and the tools used to align interests. The theory is not only useful knowledge when looking at contracts, but also when looking at decision making in the operating companies. Companies have a tendency to choose the rational profit-maximizing alternatives when making decisions, and incentive theory is therefore highly relevant to be acquainted with. Since the thesis relates to the offshore industry, the words; *company*, *operator* and *principal* will to a large extent be used as synonyms. The same applies to the category; *agent*, *contractor* and *supplier*.

2.1.1 Incentives in general

When discussing incentive theory it is natural to relate to the terms *principal* and *agent,* which is broadly used terms in general incentive theory. The *principal* is the person or organization designing the terms of the transaction (i.e. wants something done), while the *agent* is the person or organization that executes the task (McMillan, 1992, p.96). The principal and agent may have diverse interests in the starting point. Therefore the essential feature of any incentives issue is differences in the aims of the people involved. In a situation where the aims of the people involved are perfectly aligned, there is no need to create incentives for the other; the preferred action will be chosen. It is however realistically seldom possible to find agents that have perfectly aligned interests with the principal. It is therefore important for the principal to create incentive schemes that induces the agent to perform actions he otherwise most likely would not do. A large amount of the workforce in a company would for example not show up for work if they were given notice that they would not receive money in return. It is in other words not in their best interest to work if they are not compensated for their time. Some of the workers might however show up. This is because monetary values are not the only motivating factor that exists. Other factors include peer pressure, pride in craftsmanship, work ethics, fear of letting others down, reputation, and so on. Monetary values are nonetheless an important motivating factor, it is the compensation most used within industry and commerce, and is one all readers can relate to.

[11] Contract theory and contract incentives are in the continuing text used as synonyms.

2.1.2 The effects of incentives

The effectiveness of incentives is subject of political controversial, as traditional conservatives tend to believe that incentives have large effects and political parties on the left often regard the effects as more minimal. The effects has nonetheless been mapped in what McMillan (1992, p.96) refers to as *"the biggest economic experiment in history, the reforms that occurred in China in the early 1980s"*. The study investigated the behavior of Chinese peasants as they went from a system with weak links between effort and reward (the commune system), to a system with a direct link between effort and reward (the responsibility system). The transition started when the government started paying better prices for agricultural outputs in 1978 and 1979, and then gradually went from the commune system to the responsibility system during the period from 1980 to 1984. During the period 1978-1985 output increased by 67%. The increase in output was partly caused by an increase in input, but was mainly caused by the strengthened incentives, as productivity rose by 50% (McMillan 1992, p.97-98).

Even though this scenario and many others prove the effectiveness of incentives, it is vital to differentiate the effects. Incentives can be powerful, but can also yield unwanted side effects. Good examples of such side effects can for instance be; workers paid by piece-rates will often sacrifice quality for quantity, and managers paid on the basis of annual profits will often sacrifice long-run profitability for short-run earnings. The incentives can in other words lead to elements not directly tied up to the incentives being neglected or not taken into account at all. The critics of monetary incentives also often argue that it encourages people to focus narrowly on tasks, to do tasks quick and imperfect, and also that the incentive schemes can be costly to internal morale and productivity in the long run (Baker, Jensen & Murphy, 1988).

2.1.3 Informational disadvantages and risk

In many situations principal and agent has differences in information available. If the agent knows something relevant to the performance of the contract that the principal do not, the principal has an informational disadvantage. Many contractual relationships have this character, and if transferred into the contracts in the oil and gas industry, one might see the contractor as the agent[12] and the operator as the principal. The contractor often has special competence and knowledge of the work they are hired to do, while the company holds the capital. The principal therefore has to come up with a contract or an incentives scheme that takes this disadvantage into account.

There is also a matter of risk placement. If a contractor is hired to, for example to build a pilot, there are often big uncertainties involved. The pilot has never been built before, therefore costs,

[12] The contractor can naturally also assume the part of principal when dealing with sub-suppliers.

complexity and even successfulness cannot be clarified with a high degree of certainty in all cost and engineering disciplines, prior to the work. Markets for raw materials and other procurable goods also may be difficult to foresee, alongside with the behavior and performance of sub-suppliers. The contractor is often not in an economical position to take on the majority of risk related to these elements, and will therefore be more risk averse than the operator, which often has a good financial situation and is diversified in different licenses. A solution for the company to this problem is to transfer risk to contractor by making them responsible for losses up to a certain point, which represents the highest sum the contractor can be held accountable for ("cap"). This limits the contractors' risk and gives them incentives, but also creates an incentive problem if the "cap" is reached early in the project. The contractor then has no incentives to keep costs down. A solution to this problem might be bonuses. If contractor manages to reach pre-defined milestones within time and/or with good quality (Osmundsen, 1999) there is a reward. Thereby the negative incentive in the "cap" is supplemented by a positive incentive in form of a bonus. It is however important that the incentives are carefully planned throughout the projects in the specific contracts, so that incentives do not disappear when a bonus is achieved or a "cap" is reached. This is often tried solved via various compensation formats related to different tasks within the project and incentives of higher order. These topics will be further discussed in the next headings.

So what are the most essential things to keep in mind when designing incentives, one might wonder.

Osmundsen (1999) argues that according to theory there are three guidelines the companies should follow when designing incentives:

- Incentives should to the largest extent possible involve conditions that contractor has the possibility to influence.
- Incentives should be tied to quantities that can be measured (in the sense that the goal is verifiable juridical).
- Risks that do not lead to increased incentives should be eliminated.

Furthermore it is in the companies' best interest to follow these guidelines as unnecessary risk transferred to contractor will lead to a higher risk premium incorporated by contractor in the contracts, and in turn increase costs for the companies. Although these guidelines offers assistance with regards to general design, it is also worth mentioning that incentive schemes designed for specific activities (for example drilling) is still subject of research, and new strategies and schemes remains a topicality (Osmundsen, 2011).

2.1.4 Compensation formats

A main element in incentive theory is that is that the agent's compensation has to be tailored with regard to the specific situation. This in turn means that different purchases should be regulated by different compensation formats (Osmundsen, 1999). With regards to total contracts (EPC(I)) this means that one creates a form of hybrid agreement between operator and company which usually contains one of the following compensation formats, or a combination of these; *Fixed price/lump sum*, *reimbursable, target sum* and *provisional sum*. The two extreme points are fixed price and reimbursable, while provisional and target sum is somewhere in the middle. These formats have different advantages and weaknesses. I will in the following try to explain the difference between them and the areas they often are applied to.

2.1.4.1 Fixed price/Lump Sum

Lump sum as a compensation format means that the principal and agent have come to an agreement of a specific sum that the principal is going to pay for a product or service. This compensation format is according to Osmundsen (1999) most advantageous for deliveries which contain:

- *Standardized inputs*
- *Competition between suppliers*
- *No specific investments on contractor side is needed*
- *Possible to make a detailed product specification*

If the delivery contains standardized inputs (for example a certain type of steel) both operator and contractor will be in a position where estimating input costs can be done relatively precisely. If in addition it is possible to make a detailed product specification, the same applies to production costs, even though contractor has an even better overview because of their special knowledge within their specific field. The assumed competition between the suppliers gains the company's bargaining power (since they can choose other suppliers), and if there is no need for specific investments (for example new machinery) with respects to production, risk is not very high for contractor. The risk involved is also leading to increased incentives and should therefore lie with contractor. Contractors earnings in the situation specified above, is also highly within contractors control sphere, as own efficiency and cost control are deeply related to amount of potential profit.

A challenge with such contracts can be quality and delivery time. These are often regulated by penalties such as day fines, if specified quality or time of delivery is not met.

An additional aspect is that fixed prices might be favorable in situations where it is advantageous that contractor has freedom to maneuver. If on the other hand operator wishes to actively influence the product development, the contractor should not be held accountable for changes made by operator during the work (Milgrom & Roberts, 1992, referred in Osmundsen, 1999). Such a situation would implicate extra costs for contractor due to changes which is not within his control sphere; thereby another type of compensation would serve a better purpose.

2.1.4.2 Reimbursable

Through *reimbursable* contracts, contractor is refunded for all expenses related to costs defined in the contract. This means that risk is mainly placed on operator side, and contractor is subsequently only exposed to risk with regards to errors or delays. Penalties for such mistakes are often specified in the contract and often take the form of penalty milestones.

This compensation format is typically used in development projects or other complex projects where there is a high probability of many changes during the work, and the work is distinguished by a very small degree of standardization. The low degree of standardization and certainty makes cost estimation difficult. From an operator's standpoint it is also often preferable to have opportunity to influence the work during such projects. As operator will have financial responsibility for maintenance, follow up and operating, it might be cost saving to have this option. If many changes from the original plan occur, it is often a source of disagreement in other compensation formats. The two parties then have a tendency to argue which side that has to bear the extra costs, which changes tend to bring. In a reimbursable contract this is established by the compensation format and brings no such challenges. The down side for operator is that contractors' incentives for cost reducing measures are low/non existing. Another problem with operators' involvement is that it may lead to blanking of responsibility areas between the two, and thereby lead to more disagreements[13]. It is however often difficult to find contractors that are willing to take on such development contracts if operator does not take responsibility in form of covering most of the risk.

2.1.4.3 Target Sum

The third compensation format presented is a mixture of the two formats presented earlier. *Target sum* means that the two parties have agreed upon a reference price which is to be used as a basis for which expenditures operator and contractor shall cover, but also profits due to cost savings are equally shared between the two parties. Such contracts were often used in projects which were in the cross section between development and construction. This means that there exists elements of both familiar standardized technology and new. Deliveries to the NCS is often characterized by fast technology development, hence it can be difficult to separate which components that are new, as

[13] In such a situation it is plausible that contractor would blame changes made by operator as reason for potential failure to deliver on time, or in right quality. If this failure leads to loss of bonuses it might be a source of disagreement.

these are an integrated part of the whole delivery. The problem is further extended by the fact that detailed projecting, in most cases, is not available at the time the parties enter into contract negotiations (Osmundsen, 1999).

By sharing profits of costs saved and the risk of cost overruns, the two contract sides balances the exposure to risk between them. This is advantageous since both contractor and operator has incentives to keep costs down. Since the contractor, as previously mentioned, often is more sensitive to risk, it is not uncommon that a “cap” on overruns on contractors’ side is used. This leads to a reduction in contractors’ risk- bearing.

This compensation format was, according to sources within the industry, frequently used on the NCS around year 2000. The outcome was however that the reference price often was set too low (too optimistic) by the contractors in the tendering face. It is likely that this was a result of the competition towards winning contracts. As a result many contractors took on more risk than they were able to bear, and some were even on the verge of bankruptcy during some of the projects. To prevent contractors’ bankruptcy, the oil companies in some cases had to cover costs which initially were related to contractors’ risk (information from the coadjutant contractor). The operator’s initial profit of lower costs was therefore marginalized by the contractors’ consumption of too much risk.

2.1.4.4 Provisional Sum

Provisional sum can be categorized in the middle of *reimbursable* and *target sum*. In resemblance with *target sum,* a reference price is made. This reference price also contains contractors’ profit. There is however no risk-sharing for overruns as in the *target sum* contracts, and consequently no sharing of potential cost savings. In a *provisional sum* contract the payments are linked up to milestones within the project. These milestones are typically linked up to finalization of important project phases or certain percentages of project completion. Upon completion of a milestone the contractor is able to invoice the operator for the pre agreed sum of the milestone. It is not uncommon that the contractor is able to invoice a bit more than the actual work performed, to ensure sufficient cash flow to reach the next milestone. The two parties often meet at a steady frequency during the project progression to discuss changes in the reference prices. Changes can be made if variations, or other changes made by operator influences contractors’ progression. Should contractor on the other hand be to blame for delays, this is usually sanctioned in form of penalty fees and loss of potential bonuses.

This compensation form is typically used in projects with a relatively high degree of uncertainty. Operator therefore has to hold most of the risk. If operator was to insist, of for instance a fixed price contract, the contractors would have to add the risk involved to the price. This would lead to a price so high that operator would not be willing, and thus the projects would never be realized. It is therefore profitable for operator to consume most of the risk involved in such projects.

2.1.5 Incentives of higher order

Different contract strategies can be categorized in two different dimensions: *the degree of integration* between the parties and the *degree of interest alignment (*see *figure 4)*.

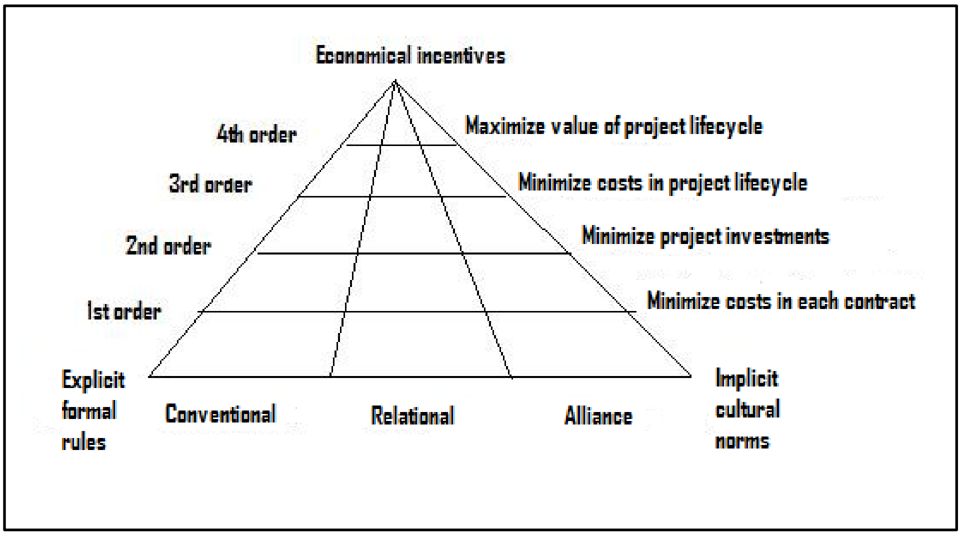

Figure 5 Framework for different contract strategies (European institute of advanced project and contract management (Epci), 1997, refered in Osmundsen, 1999).

The two extreme points are conventional contracts with arm length distances between the parties (classical contracts), and alliances where the two parties cooperate closely and has joint responsibility for carrying out the project. In between these extreme points we find so called relational contracts. These contracts are characterized by increased interaction between the parties without leaving the principals drawn up by the contract which relates to the two sides' different responsibility areas. Different incentive systems can be characterized from which degree of interest alignment the operator has chosen to compensate the contractor. We can relatively safely assume that the main objective for operator is to maximize the value of the projects lifecycle. Therefore the two extreme points here will be that incentives are tied up to cost reduction in each contract, or that the incentives are tied up to the value of the projects lifecycle. The first is of very limited significance to the project as a whole, while the latter is tied up to operators' entire chain of value.

During recent years there has been a tendency of movement form the south-west corner in the direction of the north-east corner on the NCS (Osmundsen, 1999). This tendency implicates closer relations between the parties and incentives tied up to project profitability as a whole.

2.2 Incentives for development of new technology

When looking at why pilots are delayed it is important to look at which incentives the two parties truly have to develop new technology. Some benefits of new technology have the form of what we generally see as a common good; knowledge. New technology can of course be protected by patents, but sooner or later such knowledge will be available to others. It is however doubtful that the parties involved within oil and gas see this as more than a positive externality. These are presumably driven by incentives of more commercial character such as competition advantages and increased revenue. As incentives in general has been covered previously, I will in this part try to look more thoroughly at which concrete incentives operator and contractor have for developing new technology. As contractors work up against an operator, and therefore is somewhat dependent on them, it is not enough to look at incentives within existing contracts. One also has to take into account the implicit incentives which lay within the evaluation criterions the operators use when awarding new contracts. This section is to some extent based on Osmundsen's (2011) reflections.

Operators and contractors may have different viewpoints on development of new technology, and thus different ideal situations.

For a contractor it is preferable with close relations with an oil company. This ensures user relevance and financing. In addition the contractor wants to be responsible for development and implementation; this ensures employment and increased control over the developed product. Furthermore the contractor sees long term relationship with the cooperating oil company as an advantage, and is also keen to retrieve exclusive rights to the product developed. The latter implicates that the contractor has the opportunity to sell the product to other oil companies, and that also the cooperating oil company will have to full price for rental or purchase of the product. During such a situation the contractor is armed with an increased bargaining power towards oil companies in other contracts, and a competitive edge towards other contractors.

In the oil companies' ideal situation it is preferable to have close relations with different contractors during the development. This ensures perfect relevance to the oil companies' needs and also maintains the balance in competitive edge between the contractors. The oil company is interested in keeping this balance since they want a freedom of choice when choosing which supplier to use. The freedom of choice ensures that their bargaining power is not limited by lack of competition. In other words the oil companies do not wish to be committed (or "locked in") after the development phase. Furthermore they wish to obtain user rights to the technology developed, and if possible also exclusive rights. The first ensures that they do not have to pay for the same technology twice, while the latter will put them in a position where they can sell the technology, product or service on the free market.

Even though there are diverging interests, some mutual incentives also exist. The contactor and the oil company are both interested in creating a product that can obtain added value. The divergence happens when the economical awards are to be distributed. The outcome of these negotiations is relative to the two parties' bargaining power. According to Osmundsen (2011) they are therefore regulated by the parties' number of credible options. The contractor might do well if armed with superior technology or expertise, and also if they are willing and capable to finance part of the development themselves. The oil company will presumably have an advantage if these contractor assets are minor, or non-existing.

2.2.1 Government funded research and development programs

The Norwegian government has great incentives to help oil companies increase the recovery rate and efficiency on the NCS, as a substantial part of government revenues originate from the petroleum industry. To underline this statement, the petroleum industry's part of the Norwegian GNP[14] has fluctuated between 18 and 27% during the last ten years, and the industry is also responsible for approximately 15% of the entire government revenues, due to taxes (Norwegian tax authorities, 2011). In light of the large amount of reserves which remains in the ground after demobilization, the Norwegian government has established various funding programs that seek to eliminate some of the financial risk involved with regards to research and pilot projects. It is the governments hope that these funds will lead to a more active technology development on the NCS. These programs have been welcomed by the companies, but at the same time politicians have been criticized for not subsidizing the programs with nearly enough money (Friedemann referred by Steensen, 2011).

2.2.1.1 Demo 2000

Demo 2000 was established in 1999 through a financial package of 100 million NOKs and is supported by *Forskningsrådet*[15]. The aim of the program is split in to three parts; to achieve new field development on the NCS through new cost efficient technology and new accomplishment-models, to increase security for accomplishments within budget and plans, to secure new Norwegian industrial products for sale on the global market (www.demo2000.no).

[14] Gross national product

[15] *Forskningsrådet* is funded by the Norwegian government and has as objective to give political advice within research, finance research and create arenas for research development (www.forskningsraadet.no).

This is to be done through demonstrations or pilot projects. This way new cost efficient technology will be qualified for usage, and thereby create new development projects, new products and new employment opportunities. The pilot projects will be carried out in close relations with supplier companies, research institutions and oil companies, and is therefore believed to create networks of competence as a positive side effect. This is central in a situation where the Norwegian petroleum industry in an increasing manner has to compete on the global market (cf. decreasing production on the NCS). Demo 2000 will therefore accelerate qualification of key technology which can release necessary innovation and readjustments in the industry towards future employment and products. The cooperation with the commercial industry does however not mean that Demo 2000 will cover all costs the companies bear. The intention is to combine forces between the participating parties and to eliminate some of the financial risk involved. In the aftermath it has been revealed that the companies have spent approximately three NOKs for every NOK received from Demo 2000 on the sponsored projects. It has also been reported that the cue of applicants have been long, so in principle there should be nothing missing on the participants' willingness towards innovative thinking (Friedmann referred by Steensland, 2011). In spite of receiving less money than they originally hoped for, Demo 2000 is regarded one of the more successful programs for technology development in Norway. The program has received 540 million NOKs in government funding since established, and has subsidized 215 projects. The commercial side has however contributed with approximately 1500 million NOKs. (Steensland, 2011).

2.2.1.2 Petromaks

Petromaks was established in 2004 and is like Demo 2000 funded through *Forskningrådet*. At the time of establishment, the program was planned executed over a ten year period. If these plans are to be followed the program will be terminated after 2013. The program aims to contribute in a way so that the petroleum resources obtains added value for the Norwegian society. This is to be done by increased knowledge development, commercial development and increased competitive power. Petromaks covers basic research, applied research and technological development. The target groups for the program includes universities, colleges, institutions and the commercial industry, though a condition for receiving funds is that they contribute to the development of the petroleum industry. It is safe to assume that Petromaks supports a wider circumference of research than Demo 2000, since one can apply for funds for a wide area of scientific work. These include projects for: Books, PhDs, patents and so on. Some projects financed by Petromaks also moves on to be funded by Demo 2000. According to statistics from 2008 this was the case for 13 projects during 2007 (www.forskningsradet.no, Petromaks yearly report 2008).

The program was subsidized by approximately 230 million NOKs in 2010 and projects similar yearly income over the next three year period. This is currently over half[16] of what *Forskningsrådet* has available for research within the petroleum area. According to statistics Petromaks funds in 2008[17] where spent with accordance to the *figure 6* beneath.

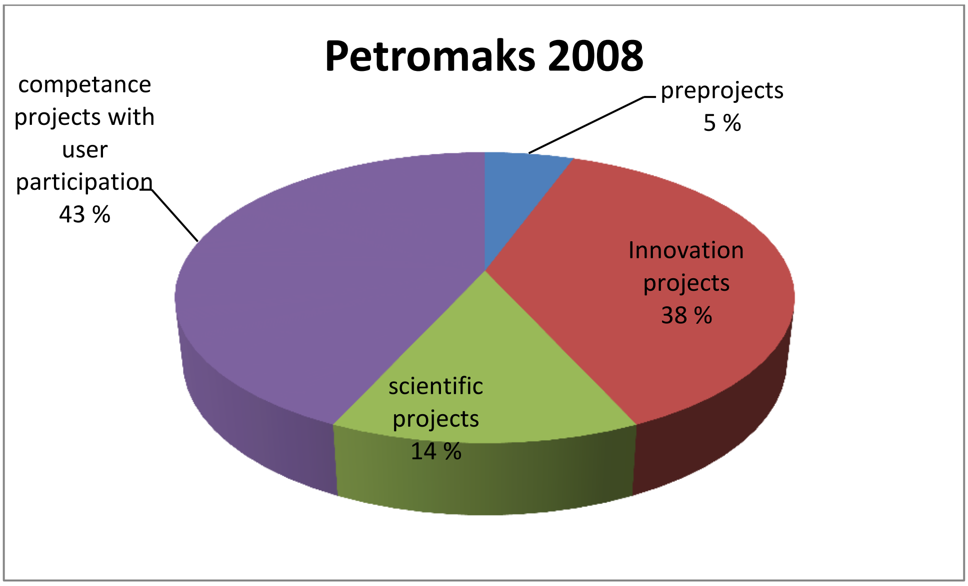

Figure 6: Type of projects funded by Petromaks in 2008 (www.forskningsradet.no)

[16] Forskingsrådets' budget for 2010 was 430 million NOKs for research within petroleum (this includes both Petromaks and Demo 2000).

[17] Newer statistics has unfortunately not been available to the author.

2.3 Standard Contract formats in the petroleum industry on the NCS

Underneath, the two standard contract[18] formats used on the Norwegian shelf will be presented in a simplified way[19]. The presentation is regarded important because contracts built up around this format will be discussed later in the thesis. It is therefore important that the reader has some knowledge about the structure in these contracts. A clarification towards the standards regulation of intellectual property will also be made, as this is of high relevance with regards to pilot projects. The presentation is largely based upon Kaasen (2006, p 19-42), since he as a lawyer for Norsk Hydro AS acted as leader of the oil companies party, during the negotiations at the creation of the standards in 1987. He later attended as an objective arbitrator at re-negotiations up until NF 05 and NTK 05[20] (Kaasen, 2006 p 5-6).

2.3.1 Presentation of NT and NTK

Norwegian Fabrication contract (hereafter called NF) is an agreed document of terms negotiated by Norsk Hydro ASA and Statoil ASA on the one hand, and Norsk Industri[21][22] (hereafter called NI) on the other hand. On October the First 2007 Statoil ASA merged with Norsk Hydro ASA's oil and gas division and formed StatoilHydro. November the First 2009, the company however changed their name back to Statoil (www.statoil.com). This means that Statoil in reality is the only formal party on the operating side of the contract today.

The contract is to be used for fabrication of large manufacturing components for the petroleum industry on NCS, and is therefore not to be confused with contracts designed for procurement of standardized goods. The parties have also agreed upon a protocol where it is stated that NFs terms are assumed used in contracts between Statoil and any of NI's member businesses. The protocol also limits the adjustments from the standard terms the negotiating parties can make in each separate contract.

Norwegian Total contract (hereafter called NTK) is negotiated between the same parties, and is largely subject to the same protocol as NF. The terms are built upon the terms of NF 92, but NTK is especially designed for deliveries that has a substantial size and contains projecting, engineering, procurement, building and possible installation. Total contracts are also known as "EPC (I)-contracts",

[18] Other standards based upon NF and NTK do exist, but will not be discussed in this thesis. Some of these are NKT MOD and NSC.
[19] The experienced reader within petroleum contracts might find this presentation insufficient, but the complexity and size of these contracts are too massive to be described thoroughly by a master thesis alone. For readers who wish to learn more about the standard formats I would recommend Kaasen (2006).
[20] NF and NTK have been subject to some revisions over the years, the most recent revisions are NF 07 and NTK 07.
[21] In English best translated to Norwegian Industry
[22] Norwegian Industry was called Teknologibedriftenes Landsforening (TBL) up until 2006.

which stands for “Engineering, Procurement, Construction and (Installation)”. The *engineering* phase includes the technical construction and the design of the object. The *procurement* part includes purchase of goods, temporary personnel and logistics that is vital for the project. The *construction* involves the actual building of the structure, and in many cases the contract also involves implementing the object, or *installing* it. The project can for example be a complete platform.

The counterpart to a Total contract is that the operating company itself is responsible and procures services from a variety of sub suppliers. The total contract has the advantage for the procuring part that responsibility for administration and coordination of the services is pushed down to the supplying company. By being in the format of a Total contract it also makes the whole tendering-process easier and yields higher certainty in relation to cost, development, modification and operation of the project. For the sub supplier this naturally means more risk and more responsibility, but it also means higher employment and increased potential for earnings.

A substantial part of the deliveries of installations and components made to sights on the NCS is contracted by NF or NTK. The duty to use the formats only lie with contracts agreed between Statoil and NI’s members, but in practice the formats is also used in contracts between Statoil and foreign contractors. The reason for this is that NI’s members will usually participate in the tender process. Either they are awarded the contract or not, NI’s members can demand that the standards are used in the tender invitations, and therefore dictate the tender documents and evaluation. Where Statoil is operator these contracts are put to use mainly without any big adjustments with respect to the individual project. This is of course logical, since Statoil were deeply involved in the creation of the formats. In other incidents on the NCS the terms of the contracts are to a large extent inspired by NF or NTK. Compared to the petroleum industry on a global stage the degree of durability and standardization of the contracts are unique.

2.3.1.1 The creation of NF and NTK

During the late 60s and early 70s operators were few and far between on the NCS. The operators, who were active, were mainly foreign companies such as Phillips, Mobil and Elf[23]. These companies used their own contract formats which mainly were developed on basis of their international activities. Norwegian suppliers regarded many of the terms as unfamiliar, as they were used to contracts formed by Norwegian traditions and legislation. The suppliers also had objections with regards to their commercial balance. Different negotiations took form and some problems were solved via an early standard in 1983[24]. The parties however continued to disagree on vital points such

[23] The companies are today named ConocoPhillips, ExxonMobil and Total respectively.
[24] North Sea Offshore Lump Sum Construction contract

as; who had responsibility to cover costs for variation orders[25], and the access operator had to change the standard agreements. In light of these sources of disagreement, negotiations started and resulted in NF 87 which formally was available the 14th of May 1987. An important aspect of this contract was that the parties continuously were to consider revisions of the standards. During the years, revision has been needed, and this has resulted in new revisions of NF and other formats which are based on NF, such as NTK, NTK MOD and NSC[26].

2.3.1.2 The protocols

During the finalization of the negotiations the parties entered an agreement called, the protocols, with regards to the usage of the standard. The protocols regulates the areas for which the standards are to be used, the limitations on individual adjustments in the terms and also states the standards are to be used in any contract between the two parties within the area of usage. Any revisions from the standards are to be announced in the tender invitation (or by revision notes in the document). Other areas regulated by the protocols include areas such as termination, procedures, publication of expert opinions and cash flow arrangements during the project work.

2.3.1.3 Why create standards?

Numerous considerations were taken into account when composing a standard contract for fabrication in the petroleum industry. Agreed standardization provided increased simplification with regards to contracting and contract administration for both sides involved. Furthermore the standard made education and training within contract administration more efficient, which is important in an otherwise rather complex area. The most important reason nevertheless was that standardization gave the opportunity to create better and more balanced contract terms. This was regarded especially important when one part became as influential as Statoil was and still is, on the NCS.

[25] The argument centered around the situation where operator gave instructions. Was this to be regarded as a change of scope, or just a modification? If this was to be regarded as a change of scope, the operator would have to cover the costs and vice versa.

[26] In this sentence NCS means *Norwegian Subsea Contract*, while NCS in the rest of the paper refers to the *Norwegian Continental Shelf*.

2.3.2 The structure of NF and NTK

2.3.2.1 Agreement

In the standard version of the contracts (NF and NTK) they are presumed signed by the sides on the last page of the contract terms, while the formal introduction to the contract is stated on the contract terms' page 1. The two sides can however decide to create "*a document of agreement*". Such a document will present the two different parties, and state that the parties are bound by the contract. The document of agreement also lists which other documents that is to be regarded as the terms of the contract. These documents are the attached *conditions of contract* and a set of listed *appendices.* If the parties should want to revise or modify the terms they can choose to do so by writing in special terms into the document of agreement instead of revising directly in the *conditions of contract*. This can however lead to problems with regards to overview, so the common practice is to revise the terms directly into the standards (Kaasen, 2006, p 67).

2.3.2.2 Conditions of contract

The part that forms the *conditions of contract*, is the actual standard of the documents included in the contract, and contains the following parts:

Part I: General conditions (Art. 1-3)

Part II: Performance of the work (Art. 4-10)

Part III: Progress of the work (Art. 11)

Part IV: Variations, cancellation and suspension (Art. 12-18)

Part V: Delivery and payment (Art. 19-23)

Part VI: Breach of contract (Art. 24-27)

Part VII: Force Majeure (Art. 28)

Part VIII: Liability and insurance (Art. 29-31)

Part IX: Limitation and exclusion of liability (Art. 32)

Part X: Proprietary rights etc. (Art. 33-34)

Part XI: Other Provisions (Art 35-37)[27]

Where I in the following text refer to "Art." this will mean an article number within the *conditions of contract*.

2.3.2.3 Appendices

NF and NTK have slightly different set ups for appendices. This is because NTK assume that the contractor will perform more of the project work than under NF. The differences are however minor if looking at the standards as a whole[28]. The appendices of NF are the following:

Appendix A: Scope of Work

Appendix B: Compensation

Appendix C: Contract schedule

Appendix D: Administration requirements

Appendix E: Specifications

Appendix F: Drawings

Appendix G: Company provided items

Appendix H: Subcontractors

Appendix I: Company's insurances, etc.

Appendix J: Standard Performance Guarantee

Appendix K: Contractor's Proprietary information

Appendix L: Parent company Guarantee

These appendices are the standard, and the respective appendices should be listed as *not applicable* in the *document of agreement* when irrelevant for the specific contract.

[27] NTK contains one more article than NF. This article is found under part XI and is called "prevention of disputes".
[28] More about the differences in the appendices between NF and NTK, has been written by Kaasen (2006, p 82-87)

2.3.2.4 Precedence and interpretation

Art. 2.3 in the *conditions of contract* define which documents that will have precedence in case of disputes. If special modifications have not been done, the *document of agreement* (if made) will have the highest precedence followed by *conditions of contract*, all appendices in the order they are listed[29] , except for appendix D, and as least precedent document, appendix D.

The standards have been negotiated in Norwegian and are therefore also written in Norwegian. An English translation have however been authorized by the two sides. The two versions are printed alongside each other in the contract templates. The English version is generally the most used since foreign project workers and contractors have to be considered. When the English version has been used during negotiations this version will also be the valid law and the basis of interpretation. The Norwegian version can however be relevant in cases where there are doubts towards interpretation. The English version can be correspondingly relevant in matters where the Norwegian contract has been used (Kaasen 2006, p. 21).

2.3.2.5 Regulation of Intellectual property in the standards

As the aim of this thesis is to investigate the balance in the contracts and map potential project stoppers for pilot projects, the regulation of intellectual property (hereafter called IP) in the standards are of high relevance. A pilot often contains new technology and therefore has the potential to create substantial earnings to its owners, either it is through sales, royalties or technical advantage towards competitors. The agenda of the regulation of IP is to protect the parties' interests and create a just sharing of rights to whatever technology that may develop within the contractual relationship. Both parties have a common interest of protecting their rights to existing technology. The Contractor seeks to protect its technology from competing contractors, and the Company seeks to protect its technology to prevent contractors from achieving "technical monopoly" and as a result be "locked in" towards use of a given contractor. This would result in a loss of bargaining power, and effects of competition would also be eliminated (Osmundsen, 2011).

IP is regulated by *conditions of contract* Art. 33 and by *appendix K: Contractor's proprietary information*. The regulations are meant as a supplement to common laws regarding copyright and intellectual property (Kaasen, 2006, p. 831).

Art. 33 relates to rights to information, technology and inventions. Rights to IP in the contract are mainly treated in two different groupings; these are *information* and *inventions* respectively. Art.

[29] As listed under the section, 2.3.2.3 Appendices.

33.1 and 33.2 separate existing technology which Company and Contractor brings in to the contractual relationship, and the technology that might develop during the co-operation.

The governing rule is that Company owns the rights to whatever information, technology or inventions developed mainly from information they themselves have provided the project with. This is a prevailing regulation independent of which employer inventor or developer is compensated from, as long as the development has occurred mainly on the basis of Company provided technical or commercial information. Should Contractor however make inventions or develop information mainly on basis of information that was brought into the project by Contractor, the rights fall to them.

The word *information* is not defined under *definitions* in Art. 1, but it is stated in the contract that these include more than drawings, documents and computer programs. The meaning of *information* can therefore be interpreted to have a wide circumference. This has been analyzed by Berge (2007) who concludes that *information* in these contracts should be understood as: "*materialized technical and commercial particulars, which contains experiences, technology, knowledge and similarities to these, that exceed common knowledge*". He then argues that information therefore will be written expressed *know-how.* The access to use know-how learnt from each other is difficult to regulate, as this knowledge is not included by the demands of for instance an invention[30].

Kaasen (2006), on his side, states that i*nformation* within these contracts is to be interpreted to have high circumference. By this he means that *information* is to be understood as the entire specter from particulars to patentable inventions.

Contractor is also bound by Art. 33., to notify the Company, if an invention that by the contract shall be Company's is revealed during the work. Contractor is then responsible to yield necessary assistance to Company to acquire patents to these inventions. Financial reimbursement shall be paid to Contractor for all reasonable costs in connection with such assistance.

[30] For objects to be regarded as an invention, certain conditions need to be fulfilled. Some of these are technological progress and inventive merit. These are adjectives which are commonly not fitting for all types of know-how, thus the information is not protected by the patent legislation.

2.4 Pilots from idea to implementation

Time from idea and lab testing to implementation on the field is a subject which has been criticized with regards to the NCS (Åm et al, 2010). To illustrate the time-frame for a successful innovation project within the oil and gas industry, I will in this heading present an example provided by the coadjutant contractor. The technology discussed is the same technology applied in contract 1 in chapter 4. Specifics around the project will not be revealed due to confidentiality issues with regards to the contracts compared later in the thesis. The development in itself is not confidential material, but to reveal the project, and thereby the contractor, would also compromise which contractor that has provided the contracts.

The reader also has to take into account that the innovation in the example is a system and not a single patent. The system has also had a quite big impact on field developments; therefore minor innovations with only marginal differences from todays practice might not have quite as extensive timelines as the example, but studies however show that the timeline in the project presented is quite common in the petroleum industry (McKinsey, appendix nr. 2) The development of the solution discussed lasted for 25 years from the first initial studies to the award of an EPC-contract on an actual field.

2.4.1 Year 0-4

During the first two years initial studies and the technology development of vital parts of the system were made. The motivation of the research was drawn from the fact that there was a potential for increased recovery rate and a substantial reduction in both CAPEX and OPEX. Furthermore the technology was more cautious to the environment, and there were no competitors in the market. The market vision therefore became to demonstrate the feasibility and hence create a market. During the next two years a project development description of the key technology were made and presented to oil companies to gather financial support. Up until this point the contractor had covered all costs of the project.

2.4.2 Year 4-9

During the following years the development project was carried out successfully. The contractor still owned and financed the project, but also received financial support from different oil companies and the Norwegian government. The funding was given through a program called, *Capitalization of Offshore Research*, which was active at the time. Even though funding was given, the contractor still covered approximately 62% of what was now a multimillion dollar development project. During these years agreements with suppliers for functionality testing also were made and endurance tests were carried out in research facilities.

After the development project the activity around the technology came to a halt for a while. External funding was needed for further progression. One therefore made big efforts to get licenses interested and willing to fund further development.

2.4.3 Year 16-20

After the technology development had a standstill for some years, the technology was refurbished and tested with actual hydrocarbons when the project was subsidized by two different Demo 2000[31] projects. These projects were in the low cost area, but were nevertheless also sponsored by different oil companies thorough the Demo 2000 programme. In addition to the extended testing, the object was improved by modernizing some of the parts. The contractor also had to make decisions regarding which power technology which was to be used within the system. To make these decisions reliability tests were performed, and agreements with suppliers with specific knowledge of the selected power technology were made.

During year 18 the contractor came to agreement with a license on the NCS to make a concept study of the technology on the respective petroleum field. The concept study consisted of a preparation study where specifications were made, a critical component maturing programme, and a familiarization study where vendors to existing technology were screened.

2.4.4 Year 20-25

After the concept study the contractor came to agreement with the same license to build the actual system for testing. To build the system the contractor was awarded a pilot EPC-contract. The system was not to be installed on the actual field, but was to be constructed and tested against partly artificial well flow. During the period of testing the companies within the license would have the chance to reduce uncertainties towards capacity and operational regularity. During the 25th year of development the technology was purchased by a different license through an EPC-contract.

2.4.5 Summary

This is an example of the time it might take to develop new solutions towards the oil and gas sector. The main obstacle is often funding since contractors rarely are in a position where they are able to invest large sums in an extremely uncertain project. Due to the large uncertainty it is also difficult for decision makers to calculate the profitability. Typical ways to calculate profitability also favors early earnings (net present value calculations) and somewhat marginalizes earnings made after a long time span. It is therefore possible that long time development projects, like the one discussed, would come out with a negative net present value. When the technology is fully developed and operational,

[31] See 2.2.1.1 Demo 2000

the potential profits can on the other hand be much higher than one originally has taken into account at an early stage. To make an effort to shorten the time between ideas/lab testing to pilot testing on actual fields therefore should be focused on. Sources claim that the long time span often is due to problems with funding, but also general conservatism in the petroleum industry. The long time span for industrialization has also been mapped by a study performed by McKinsey. The result show that a much longer time span from idea to penetration of the market can be expected when involved with the energy and petroleum industry, than what seems to be the case for other industries. The results of Mckinsey's study are attached in appendix 7.2.

2.5 Decision strategies in operator companies

When making business decisions one often seeks to maximize profits. Although this may seem like a simple thing on the surface, there are often big challenges attached to these decisions. One has to take into account the company's current situation. This involves topics such as cash flow, equity, market, competitors and so on. Other challenges such as short time profits and long term profits also play a part in the overall picture decision makers are faced with. This applies to oil companies as to any other company. Oil companies are however quite dependent on new technology. This is, as previously argued, not only important to increase their revenue, but also government revenues if seen in relation to the NCS. This should in all reason lead to sufficient incentives for developing new technology and green-lighting more pilot projects. Real life is however often of a more complex composition than theory. I have in the previous sections[32] argued that incentives might have some negative effects. It is often not that the incentives do not work, but that they collide with other interests and therefore can cause some undesired outcomes. In this section I will briefly try to explain some of the factors which are regarded potential pilot project stoppers within decision making. Some has been suggested by the Extraction committee (Åm et al. 2010), while others have been suggested by other theoretical work. The purpose of this section is to explain the potential problems within these areas, before I in the later sections present questionnaires where the oil companies have been faced with questions related to these topics.

2.5.1 Economical defensible on one or more fields

An important topic in all economic decision making is which revenues one compares ones' expenditures to, when deciding which investments to pursue. In the matter of pilot projects on the NCS the question is then which revenues the cost of pilot projects is seen in comparison to. Does the cost of a pilot project have to be defended by the revenues of a field alone, or does one take into account the positive effect (for example IOR) this technology can have on other fields in the portfolio as well? Historically this topic has not been quite as relevant for the NCS, as many of the early fields were of such a great size that such problems did not have to be addressed in the same way. As many fields on the NCS slowly have entered tail production, and new fields are of smaller size, this problem has higher relevance. Revenues from these fields are logically smaller and costs of a pilot project therefore will have greater impact on the field economy as a whole. This topic has been raised by the Extraction committee (Åm. et al., 2010, p. 45), where they argue that this can create bottlenecks with regards to green-lighting pilot projects. It is therefore an advantage if the oil companies take this into account when doing profit calculations. This is however not as easy as it may sound, as the effect of the technology can be somewhat uncertain at the time these calculations have to be made. On the

[32] See 2.1.2 The effects of incentives

other side, disregarding the effects on other fields would create a situation where the project would appear less profitable than it actually may be.

2.5.2 Voting rules within licenses

Another topic suggested by the Extraction committee is the internal voting rules[33] within the licenses. Typically the licenses on the NCS consist of a group of different owners with different owner percentages. The voting rules are defined in the license with legal basis in the directive of concession. The voting rules have not been altered since 1984, but have been somewhat revised. The main principles are that:

- No single company shall have the authority to make decisions alone
- None of the companies shall have the right of veto
- Decision are made based on a combination of number of owners, and owner percentage

The voting rules are supposed to strengthen the minority and have to be seen in light of the one major participant on the NCS (Statoil). The down side is that minorities can influence decisions that might lead to added value on multiple fields, but might not contribute that massively to profits on the given field alone. Some minor owners may not have interests in that many fields. Therefore they might be in a position where they do not benefit from these investments on other fields, and as a result votes against them. This problem might lead to a situation where profitable pilot projects will not be green-lighted due to internal voting rules in the license.

2.5.3 Key Performance Indicators and personal incentives

Key performance indicators (KPIs) is a measuring method which is often used within different companies to part up and structure the company's internal activities, for example specific project goals.(Osmundsen, 2011) To achieve an effective administration and to clarify goals this is often regarded as a helpful tool. The performances are then evaluated against the KPIs and often also individual bonuses are linked up to the degree of attainment. The advantages with this method are that departments and projects are aware of what to do, and what parameters they are measured upon. The challenge is to find good parameters to measure the performance. Measurable performance often includes volume, cost and time, but often be focused on at the cost of quality, life time costs and flexibility. Osmundsen (2011) argues that these effects can lead to sub-optimization as the KPIs only catches the effects of the single project or departments and does not relate to other departments or other projects. Furthermore quality, life time economy and flexibility are

[33] See Åm. et al., 2010, p.21 for explanation of voting rules in detail.

characteristics that might fit on certain new technologies. If these effects are not evaluated they can potentially lead to unbalanced decisions.

KPIs are often tied directly up to leader bonuses/personal incentives. These also might have a negative effect when considering pilot technology. To illustrate this I will use an example partly based on Osmundsen (2011). A platform manager is asked to allow the implementation of a pilot on his platform. The pilot might lead to improved oil recovery, and thus increased revenues, also on other fields. The platform will however have to shut down for a while to implement it. The platform manager has bonuses tied up to production volume only on the specific platform; he is therefore inclined to say “no”. The request for a pilot therefore is turned down. It is therefore vital that the companies adjust their KPIs with accordance to implicated fields, so that divergence of department interests does not supersede company interests.

2.5.4 “Champions”

When confronted with decisions within a company towards special projects, it is hard to avoid discussing personal influence. Although companies often strive to make rational and calculated decisions it is not entirely unthinkable that people with charisma, inner drive, good network and special knowledge can influence decisions, maybe especially decisions with a high degree of uncertainty. This is of course also even more thinkable if the personnel in question have a leading role. Such persons are often called “champions” in organizational literature. Several definitions of champions do exist. A definition of *innovation champions* made by Jenssen and Jørgensen (2003) is the following:

“*A champion is an individual that is willing to take risks by enthusiastically promoting the development and/or implementation of an innovation inside a corporation through a resource acquisition process without regard to the resources currently controlled”*

This definition is however not meant for personnel in leading roles which possesses the necessary authority and resources.

Tough it seems to be a certain degree of consensus among researchers that champions make a significant impact on innovation decisions , (Jenssen & Jørgensen, 2003) it is challenging to measure the effect of an individual, as one would not know for certain what the outcome would be if the individual was not there. The operators have however been faced with the question and been asked to give their consideration towards such persons with regards to green- lighting pilot projects.

2.5.5 User involvement in technology development

It is believed that that user involvement, in this case oil companies, at an early stage of technology development is important. This ensures user relevance for both parties, while it also may be important towards funding for the developer. It is also suspected that close relations with the actual inventors, or developer of the technology through the whole process is important. This is believed to enhance the chance of funding since the company is familiar with the potential of the technology at an early stage.

2.5.6 Time horizon

Another topic in decisions is time horizons. Decisions can often vary substantially if based on different time horizons. If the companies operate with short time horizons which favors volume affects in near future, a pilot which contributes by only small benefits in the near future, but has substantial potential in the long run, will be marginalized and stopped due to horizon based factors. This can also be seen in light of leader incentives. Davis and Martin (2010) argue that average tenure for CEOs has decreased from eight to four years during the last 20 years. This might lead to CEOs focusing on more short terms pay-offs than long term. CEOs thereby need to demonstrate their capabilities faster and may also have short term incentives in stock ownership. As pilots potentially can be investments in the billion dollar area, it is the authors' belief that these investments have to be sanctioned by the CEO. Internal compensation schemes are however regarded as difficult to access by an outsider, but the companies have nonetheless been asked which incentives leaders have to initiate pilots within the company.

2.5.7 Free passenger-problem

With regards to new technology on the NCS another topic discussed by the Extraction committee (Åm.et al, 2010) is the free-passenger problem. The licenses on the NCS do, as previously mentioned often consist of multiple owners. The companies have different percentages of ownership and thereby have to cover different percentages of the costs. It is therefore thinkable that a pilot project on a given field can be of quite severe costs to one company, while much smaller for another company within the same license. The company with the small percentage is still part of the owner group and thereby has the same rights to the technology as the company which is exposed to costs and risk at a much higher scale. One might wonder if this is something the companies take into account when deciding whether to green-light a pilot or not.

2.5.8 Competition around technology and ownership

Osmundsen (2011) argues that it is important for oil companies that competition around new technology exists. In a situation where competition exists the oil companies retain their bargaining power with “freedom of choice”, while in a technical monopoly they lose their bargaining power towards the supplier. If a supplier with a technical monopoly is chosen this might also affect future modernization and maintenance of the system. It is argued that oil companies generally does not wish to have binding connections towards suppliers, once new technology has been tested and qualified for use.

Another aspect is ownership to the technology that is being developed. This is believed to be less important than the rights to use, but the operators will nevertheless seek to own as much of the technology as possible. If operator gains ownership they are able deny the technology to competing companies or to achieve profits through royalties and licenses.

3. Method

Method in a scientific meaning can simply be defined as the tool one uses to answer ones' problems. Within science, method is usually categorized into two sub-groups depending on the analysis. The two types are *qualitative* and *quantitative* analysis. Qualitative analysis can often for instance be the understanding of a phenomenon and relates more to understanding (for example history research and field research) while a quantitative analysis has to do with amount, numbers and sizes (for example political surveys and surveys of customer satisfaction). The two methods can also be used combined, and many researchers argue that this gives the best results (Grønmo, 1996 referred in Arntzen & Tolsby, 2010). In the two sections beneath I will try to clarify the methods used in the two different parts of my thesis, and also discuss some of the pros and cons of the choices that were made.

3.1 Pilot Contracts

The method applied in the first part of this thesis is a comparison of pilot contracts with respects to five different critical subjects within the contracts. The interest is to find patterns, differences and possible connections in the material. Is it so that the contracts prove to be consistently unbalanced? Based on the number of contracts reviewed one can hardly argue that the research is of much quantitative nature. Such research is according to theory (Arntzen & Tolsby, 2010) more of a qualitative character. The method was chosen on background of availability, since this was an insight I could gain from the cooperative company. The five areas of focus (ownership, right of use, finance, earnings and technology) are key subjects within such contracts as they to a large extent govern the economic rewards, and thus are assumed relevant for the problem addressed. The contracts are usually quite extensive, and have a much wider circumference and level of detail than these five subjects cover. In the chase for patterns, one therefore runs the risk of over simplifying, and as a result loose complexity and variation in the material examined. To try to prevent this from happening I have had help from the people who were participating at the actual contract negotiations for the comparison.

There are two main methods one can apply when examining material. In the first method one pre-determines categories or subjects to look for in the material. In the second method one examines the material and make subjects and categories on the material examined (Arntzen & Tolsby, 2010). The method used in this thesis is the first. The advantage with this method is that one knows what to look for and therefore can sort out irrelevant material. The downside is the possibility to miss information that can be relevant, but do not fall directly into anyone of the pre-determined categories. To make the comparison as good as possible, I have, as previously mentioned, had help from professionals within the area. The five categories were also to some extent suggested by them, so they can in a way be viewed upon as professional suggestions.

3.2 Questionnaires to the operating companies

The method applied in the second part of the thesis is a questionnaire (See Appendix nr. 1) answered by two different oil companies. The material investigated has to do with strategic decisions and therefore often relates to the companies' strategy. The company strategy is often regarded as a business secret and is therefore not easy revealed to outsiders or competing companies.

Since the questions in the questionnaire are quite concerned with internal systems, schemes and strategy, and therefore may be a matter of some secrecy, it was regarded as a disadvantage with a formal interview. Interviews have the advantage that the interviewer can contribute with follow- up questions with regards to misunderstandings, or concretize if there is detected vagueness in the answers. This can however be counteracted in a questionnaire by formulating questions that hardly can be subject of interpretation. Asking too specific questions, on the other hand, can also lead to few answers if one touches upon subjects which are in conflict with confidentiality concerns.

With regards to the topics addressed above the questionnaire was created with some specific questions directly linked to project stoppers previously suggested by others, some to internal practices around pilot projects and also questions which are fairly open to thoughts and facts the interview object wishes to share. In some of the questions there is added a section with information beneath. This was done so the meaning of the question not would be misinterpreted. It is also worth mentioning that in accordance with upright and honest behavior I informed the oil companies of the cooperation with the contracting company and the confidentiality of the thesis, which is five year long. Because of the confidentiality I was not able to promise the oil companies a copy of the thesis. This may have influenced the answers, but I tried to counteract the possible effects by promising to make their answers anonymous within the text. Which oil companies that participated, and what their respective answers were have therefore not been revealed to anyone.

3.3 Sources of error

In almost all scientific work there are sources of error and limitations. This thesis is of course no exception. The amount of material and the access to relevant facts are apparent limitations, but as information (especially current information) is hard to get insights to from an outsider, one needs to do the best of what is available. The material used has been reviewed with as objective eyes as possible. In the next headings I will try to discuss weaknesses and limitations towards both the pilot contracts and the questionnaires.

3.3.1 Pilot Contracts

I have examined three pilot contracts. All the contracts have the cooperating contractor as one of the parties. This in turn would mean that the outcome of the contract negotiations will be affected by this contractors' relative bargaining power[34], and thus may not be representable for all contractors.

A limitation is also that only three contracts have been reviewed. From the impression of statistics created by Demo 2000, they have sponsored over 200 projects since the start and still there have been more applicants. This gives the impression that the activity within the area is quite high. Three pilot contracts therefore might seem little, but as these are extensive contracts it is difficult to review very many of them. There is also the matter of gaining access to the contracts, which can be difficult with regards to the confidentiality. Even though there are some limitations with regards to amount, it is the authors' belief that the contracts might provide a pointer towards general practice within the area.

Some would maybe also be concerned by the fact that only the contractor has given their insight with regards to their views on the contract, and could therefore argue that the interpretation can be somewhat one-sided. This can be counteracted by the fact that the author has been allowed to see the actual texts, which also operator has agreed to by signature. Contractor can therefore not present facts that are not written in the contracts, and thereby should exclude a one-sided interpretation.

As previously mentioned the five pre-defined categories might lead to some relevant information, which falls outside the categories, being left out. This is due to the extensive circumference of the contracts. The contracts are of such size that they cannot be compared to detail by a master thesis alone. The strict rules of confidentiality also prevent a detail based comparison. It is however likely that the comparison can serve as an image of the general balance between the parties.

3.3.2 Questionnaires

The questionnaires were e-mailed to the participants (oil companies) after agreement on telephone. The companies were given notice of the confidentiality of the thesis, but still was explained that a contactor would be privy to read the material. The oil companies were however to be held

[34] See heading 2.2 Incentives for development of new technology for explanation of bargaining power.

anonymous within the text. One therefore has to take into account that the oil companies would consider that potential business opposites would read the material, and that they therefore would be a little vague in their answers. As some of the questions also touch upon subjects often viewed as a business secret, one also runs the risk of getting very general and short answers.

Another limitation is that the author has had no opportunity to check if the individuals who have answered the questionnaires have complete knowledge of all the subjects included in the questionnaire. It is often common practice that all individuals are not given, or has acquired information with regards to all aspects of such decisions. It is however the authors impression that the questionnaires has been answered by individuals who possess sufficient knowledge within the area.

3.4 Summary

The two methods of research have their limitations both in amount and execution. It is not the authors' opinion that the research alone can explain all project stoppers for pilot projects, or point to some conclusive answers. It is however plausible that the thesis touches upon some of the areas which can influence pilot projects. This way the thesis might serve a purpose to narrow the search down for others reviewing the same or similar topics.

4. Experimental

4.1 Introduction to contracts

In relation to the thesis I have been granted three pilot contracts which I have been privileged to read and use as empirical material. I will therefore in this section of the paper try to briefly explain how these contracts are designed, before I compare them to one another in chapter 5. My area of focus is on input factor on the one hand, and profit on the other hand. As these are quite extensive contracts a comparison in detail is difficult, and also excluded by the confidentiality agreement. To help me draw conclusions on the focus area, I will therefore try to examine five different aspects in the contracts:

- Rights to technology
- Right to use of technology
- Finance
- Long-run earnings
- Ownership to hardware

In addition I will try to analyze if the risk placement is unbalanced with regards to ownership and right of use. This means that any of the parties has managed to place a disproportionate amount of risk and costs on the opposite party, and still managed to retain much of the upside.

The two aspects; *Right to use technology* and *Rights to technology,* might seem similar to some. They are however defined quite different. *Right to use technology* relates to the actual usage, while *Rights to technology* relates to ownership, patents, and commercial exploitation of the technology.

Specific costs for the projects which the contracts have been agreed upon are specified within the cost class categories; high, medium and low.

The contracts have been made available to me under strict rules of confidentiality, therefore company names, location of installation (other than NSC) and specifics around the projects will not be revealed to the reader.

4.2 Presentation of contract 1

The first contract presented in this thesis is an EPC- contract between operator A and contractor B with regards to building a pilot which is to be tested against partly artificial conditions. It is stated that the operator is acting on behalf of the owner group that owns the license. The pilot consists of a subsea solution, and the aim is to increase recovery rate on the intended field. It is however also an aim to reduce costs, as the solution in theory should be more cost effective with regards to both CAPEX[35] and OPEX[36] than existing solutions. If successful, the technology can be used on both existing and new field developments in the future.

4.2.1 Rights to technology

The articles containing proprietary rights in the contract has been substantially revised compared to the standards. As a problem towards contracts that contains new technology often is that the contractor seeks to protect their technology, while the operator wishes to ensure competition, this matter can be subject of time consuming negotiations. This has however been solved through an agreement of definitions related to *units* and *the system* respectively. *Units* is to be understood as different components of the system which contractor according to the contract shall deliver, except for operator provided materials which also shall be incorporated in the system. *The system* is to be understood as the complete solution/object that the contractor shall deliver. If the operator is able to pass on information about *the system*, they can create competition in a tendering period, while the contractor gets their key technology protected through ownership of technology within the *units*. This is the case in this contract and the overall thought behind the negotiations regarding ownership to technology in this contract.

One of the standard rules in contract negotiations often is that technology which were developed prior to the work is to be owned by the company of origin, this rule has also been applied here. It however states as a starting point that all information shall be the property of operator before exceptions are stated. This will have to be interpreted as that any situation not touched by the exceptions will mean that operator has ownership. It is however stated as an exception that this phrase does not mean that operator has rights to information developed by contractor prior to the work.

The contract also follows the standards towards operators' right to inventions developed during the work and within the scope. The operator has also been made entitled to inventions made outside the scope of work during the project if they have been developed on the basis of the contractual work.

[35] Capital expenditures
[36] Operational expenditures

The contractor has however defined units in the contract that contractor shall have sole rights to. These units consist of the key technology within the system. Inventions and development regarding these units is to be considered contractor's property, regardless if they have been made prior to or during the contract. Operator has nonetheless secured rights to all relevant information about these units, but only for use with regards to procurement, repair and modification, and so on. It is stated that these rights cannot be exploited to fabricate or have fabricated the technology, and they cannot be used towards other licenses than the current license.

Should however the operator decide that another contractor is awarded the EPC-contract for construction of the system on the actual field, contractor has agreed that they are willing to either fabricate and sell these units to this particular contractor, or that the operator has them fabricated. Should such conflicts with contractor's patents and ownership arise, both situations will entitle the contractor to a pre-determined compensation.

In other words it would appear that the operator has secured that it will be able to create competition with regards to the EPC-contract on the actual field, even though compensation has to be paid to the coadjutant contractor on the pilot project if they are not chosen. The contractor has been able to secure their technology against use without getting compensation. The compensation also has to be priced into other potential offers for the EPC-contract of the field, and thereby creates incentives for the operator to choose the coadjutant contractor for the implementation on the field.

4.2.2 Right to use of technology

The contract states that contractor is to give operator (and subsequently all owners in the license) an irrevocable, royalty free, non-exclusive right to use inventions and information mentioned in the article. This is to be done for use in connection with procurement, design, operation, maintenance, repair, modification, extension and rebuilding of the system on this specific construction. This rule applies regardless of at what time the inventions or information was developed as long as they are relevant for the system and comes in connection with the points listed above. Since it has been specified in the contract that the rule only applies for the specific construction, the operator has no right to use of the technology for other purposes than the specified construction. For the contractor this specification functions as a clarification to prevent owners within the license to exercise their rights with regards to other situations than the specific project. Such situations could be the building of similar constructions on their own, or that they are able to provide other contractors with technical information to ensure competition around contract awards in the future. Operator on the other hand needs assurances that they do not have to pay for the same thing twice as they may need maintenance, modification and so on, further down the road. They therefor need to define that they are entitled to information and user rights with regards to this.

It is however also stated that contractor is to be given an irrevocable, royalty free, non-exclusive right to use information and patents developed in the project which the operator has legal right to, for use in their own business, as long as it is not in conflict with a third party.

4.2.3 Finance

The compensation format of the contract is provisional sum[37], with some elements of lump sums. The cost elements has been broken down in categories and is furthermore priced by; a provisional sum in addition to a lump sum, only a provisional sum, and in one category only a lump sum. The category containing just a lump sum is a minor fraction of the project cost and is also a category which is fairly standardized and thereby quite easy to estimate. The choice of provisional means that contractor has incentives to reach certain milestones to receive payment. The reference prices can be negotiated by the parties if operator is ordering changes that lead to increased costs for contractor. Provisional sum also implicates that operator is the main bearer of risk. The contractor is however exposed if responsible for errors or delays. The contractor is also exposed to financial liability through accidents and damage to the product while in their control. The liability is however "capped" by a sum that the financial claims for such situations cannot supersede.

The project can be categorized in cost class; high

4.2.4 Long-run earnings

The long-run earnings for operator in this case relates to further development and testing of a system which potentially can increase revenues substantially in relation to both saved costs and increased recovery. Direct involvement and influence on construction and testing also allows them to tailor the design toward their specific needs. The experience gained towards the construction of the system can also be an advantage if the operator decides to make use of the solution on an actual field. Errors made and weaknesses discovered during the pilot can then be prevented and taken into consideration during the construction of the potential field installation.

The contractor also gains multiple long-run earnings. One of the earnings is experience. As the contract has the form of an EPC-contract the contractor receives experience within all these disciplines towards construction of such solutions. This generates enhanced efficiency and knowledge the next time the contractor is awarded such a contract. The experience can also be useful when competing for other contracts as the contractor now should have reduced uncertainties

[37] See 2.1.4 Compensation formats for further explanations

with regards to own costs. Another advantage is that the contractor is able to test their technology and at the same time receive payment. A successful pilot project, and the fact that the technology has been awarded funding by an active license, also functions as advertising towards other licenses on different fields. If the pilot is successful the contractor is also equipped with a new product they can sell.

4.2.5 Ownership to hardware

The parties have agreed that the hardware (or system), after delivery, is to be seen as operators' property, but only for use at the intended pilot sight. This means that the pilot cannot be used at alternative locations, and is only to be used with regards to testing for future installations. Furthermore the items included in the system that is to be delivered are defined thoroughly

4.3 Presentation of contract 2

The second contract is made in cooperation with the government funding program, Demo 2000. The contract therefore follows their model towards contracting. The parties within the contract consist of four oil companies, Demo 2000 and the cooperating contractor. The pilot involves subsea equipment meant to improve existing solutions in relation to costs.

4.3.1 Rights to Technology

The contract is loyal to the main rule that all information and inventions made prior to the project shall remain the property of the originating company.

This contract also gives contractor all rights to information or inventions made during the project, as a cause of, or as a result of the project results. This rule however states that this right only is applicable if the results are based mainly in the basis of concepts or information the contractor has provided the project with.

The contract also states that contractor has the right to file possible patent applications on inventions made under the project. It would therefore seem that the right to own technology in this contract to a large extent falls to contractor, while the participating oil companies mainly get the right to use the products or further develop them.

4.3.2 Right to use of technology

The parties have agreed that each participant[38], its affiliates[39] and its co-venturers[40] shall be given a royalty free, irrevocable, non-exclusive and non-transferable license to any patents based on the result of the project. The license should however be limited to use for *normal operations*. The same rule applies for rights to further development of project results, and subsequently with the same limitation. *Normal operations* is here meant to set limitations on further commercial exploitation of the project results, such as sale of the technology to other companies , or transfer of technology to branch companies which might have a different field of business. The limitation does however not include the right to apply the results within their normal operation, such as for research activities and operations where the party in question is either operator or technical assistant to operator.

[38] Any party that has signed the contract and is contributing through funding
[39] Parent companies or other companies in which the participant has an ownership of 50% or more
[40] License partner(s) other than the participant

The contract also states that contractor shall be free to tender or deliver equipment based on the project results to any third party, but in case of capacity problems the participating oil companies shall be given priority.

On the other hand the participating oil companies shall be free to invite any company to tender based on the project results for any field development, as long as the contractor also is invited to tender or prequalify.

4.3.3 Finance

In this project the participants have agreed on the following finance scheme:

- Oil company 1, 12,5%
- Oil company 2, 12,5 %
- Oil company 3, 12,5 %
- Oil company 4, 12,5%
- Contractor, 25%
- Demo 2000, 25%

The costs are based upon a pre-defined stipulated budget. The parties have the opportunity to re-negotiate the initial budget if a more extensive project is required.

The project can be categorized in cost class; low.

4.3.4 Long-run earnings

One of the long term earnings for the operating companies is that they gain knowledge of the technology. Should the technology prove cost effective and successful they have also already been given right of use and will therefore not be charged with license or royalty fees. Since they are in a position to monitor and follow the development it is also possible for the operators to influence the development, so that they might get a solution which is tailored for their needs.

The contractor has long time earnings in form of the funded development. Contractor is able to test the technology without bearing all the related costs and risk. Furthermore the contractor is in a position where the result might be, that they get a new product to sell, and possibly also a competitive edge towards competing companies.

4.3.5 Ownership to hardware

The parties have agreed upon that the contractor shall be owner of the hardware developed constructed during the project.

4.4 Presentation of contract 3

The third contract is a project concerning an operator and a contractor. The pilot consists of subsea equipment and aims to improve oil recovery and both CAPEX and OPEX. Neither NF nor NTK standards have been used, as this project involves a foreign operator. The contract format is however similar to the Norwegian standards, so one might suspect that these have been used as basis also when the parties have constructed this format.

4.4.5 Rights to technology

The article involving proprietary rights and patents starts with stating that all information or patents relevant to the work or contract are to be retained by the respective parties. This can be interpreted as a commitment to retain rights and patents to key technology which is to be used during the project to the extent possible for both the parties. Furthermore it is stated that all information and patents the two parties has developed prior to the contract (before the effective date) shall remain the property of the originating company.

After the effective date of the contract the following guidelines is to be followed:

Contractor has the right to information or patents, wholly or mainly based upon information that contractor has provided the project with.

Operator has the right to information or patents, wholly or mainly based upon information that operator has provided the project with. Operator also holds the right if the developments are part of the work defined in the scope of work.

In accordance with the Norwegian standard formats, contractor is also bound to assist operator to achieve patents and information that company is entitled to within reason. Costs in relation to such situations are to be reimbursed by operator.

An additional situation is also sketched within this contract. This situation outlines the outcome if developments are made based on information that both parties has contributed to. This point states that if this situation occurs, and one cannot associate it with the other situations outlined, both company and contractor shall have joint rights to the information and patents.

Should the situation occur, that company and contractor are to share patents and information, as outlined above; the two sides are to equally share the costs.

4.4.2 Right to use of technology

The right of use is thoroughly defined in the contract. It states that operator shall have an irrevocable world-wide, royalty free license to use any industrial property rights in contractor possession upon the effective date of the contract, which relates to the delivery. This right also includes technology developed within the scope of work, which is based on operator provided material. There is however limits to what operator can use this information to. Operator may not use the information to manufacture, perform, have manufactured, or have performed any system, product, process or procedure covered in whole or in part by contractors' property rights. This rule shall apply regardless if the rights are in contractors' possession on the actual date, or rightfully shall be contractors'. This means that operator will not be able to use the information for other purposes than specified, even if the contractor is not yet aware if the information, as long as it rightfully shall be the property of contractor.

The usual phrase of non-exclusivity is left out in this contract. It is possible that this has been left out because the contractor has ownership to a large portion of the technical solutions prior to the contractual relationship, or that contractor also is negotiating with others towards implementation of similar solutions. In the last case the non-exclusive clause would be unnecessary as exclusivity already has been broken.

4.4.3 Finance

This contract has been agreed in form of a fixed price contract. Normally contractors would not agree to a fixed price contract in relation to pilots. This is because pilot projects are associated with substantial risk and low degree of standard construction and development; this implies that costs are difficult to estimate. In this specific project many parts of the pilot were however tested before the actual pilot project on sight. This was paid for by operator and therefore contributed to erase some of the total risk faced by the contractor during the actual project.

Another point that contributed to the agreement of a fixed price contract within this project was that there has been agreed a liquidated damages clause. This clause states that if the project is delayed or wrongfully constructed, due to circumstances which lie with the contractor, contractor cannot be penalized by more than an agreed sum, or percentage of the project costs. This eliminates some of the contractor risk, and is one of the reasons as to why a fixed price contract has been agreed.

This project can be categorized in cost category; high.

4.4.4 Long-run earnings

With regards to this project, earnings for the operator includes improved oil recovery and reduced cost with respects to both initial and operating costs. Furthermore, operator is included in the development and therefore gains early access to the product. This enables the operator to influence the development towards own needs.

Earnings for the contractor obviously include payment, since this project includes delivery of the system for actual implementation. The contractor also receives earnings in form of full-scale actual testing and implementation of their own product. If successful the contractor is also equipped with a new product to sell on the open market. As the oil and gas industry is known for their conservative attitudes, the author has also been informed that a successful full-scale pilot on an active field, helps to create acceptance in the market, and of course also serves as extremely good advertising for the product.

4.4.5 Ownership to hardware

Since this is a project on an actual sight of petroleum extraction, the hardware shall according to the contract be operator’s property after fulfillment of the contract.

4.5 Questionnaires answered by operating companies

In this part of the thesis I will present the answers I have been provided with from the different operators. Initially four operators was asked to participate, and all agreed to receive the questionnaire. After a lengthy waiting period, two of the operators however declined to answer. The questionnaires have therefore been answered by two operating companies, and will be referred to as operator 1 and operator 2 respectively, under the different headings. The answers provided underneath must be seen in accordance with the theoretical foundation in heading 2.5. and the actual questionnaire in appendix 7.1. All questions in the questionnaire has not been given its' own heading, but information from all questions is incorporated in the report. The answers will be further discussed in heading 5.2.

4.5.1 Economical defensible on one or more fields

Operator 1 has answered that they do indeed make initial calculations based upon the assumption that the pilot is to be defensible on a single field alone. If this is not the case, but the technology seemingly will be profitable to many fields in connection, this is taken into account. One can for example, experience that one field cannot make use of the technology, but have optimal conditions for testing. At the same time another field might make use of the technology, but do not have ideal conditions for testing. Such things are according to operator 1, carefully taken into account.

Operator 2 states that they, in accordance with operator 1, initially make calculations based on a specific field. They also state that effects on several fields, in some cases has been taken into account, but at the same time admits that if the calculations demand several fields to be taken into account to show profitability, this complicates the project. This can be especially complicating if one in addition has to take into account fields outside the NCS.

4.5.2 Voting rules within licenses

Operator 1 states that they have never experienced a situation where minor parts of the license have stopped a pilot project, that the bigger parts have green-lighted. Operator 1 therefore does not see the voting rules within the licenses as a problem with regards to technology development.

Operator 2 states that they have not been part of licenses where minor parts have stopped pilot projects.

4.5.3 Key Performance Indicators and personal incentives

Operator 1 states that consequences with regards to technology testing, like increased downtime, shall be taken into account and be incorporated into the decision material, which in turn these decisions are based upon. In addition one takes into account that unforeseen events may occur during such projects. Such events are incorporated when target figures are developed in relation to, for example production KPIs for the single platforms.

They also state that they have no big personal incentives tied up to implementation of new technology, other than superior incentives for the company as a whole. These include incentives like increased production, better security and safety, reduced effect on health and environment and reduced costs.

Operator 2 states that consequences potential testing of new technology might inflict are taken into account when target figures for KPIs is developed. It is however possible that adjustment of KPIs has a certain delay. This means that decisions to test technology might be made more rapidly than the adjustment of KPIs. If late adjustments of KPIs should have a negative impact on dimensional accuracy in one period, they shall however be adjusted accordingly in the next period, so that they do not lead to unfair measurement during the production year as a whole.

As adjustment of the KPIs is made on a regular basis, they should in theory not lead to a negative impact on personal incentives related to company goals. Operator 2, however also states that they have few bonuses/positive incentives tied up to development of new technology. The personal incentives are mainly tied up to none monetary values such as honor and respect.

4.5.4 "Champions"

Operator 1 states that champions within the organization might be an important factor. They state that ownership to the technology and the ability to follow the technology during the whole course of development are important success criterions. With regards to such criterions champions might play an important role.

Operator 2 states they almost cannot emphasize enough the importance of champions to achieve technology development. They consider it extremely hard to overcome obstacles on the way to implementation, if not a champion who has ownership and expertise on the technology does not represent the technology with regards to funding and test time.

4.5.5 User involvement in technology development

Operator 1 states that this is another important success criterion. They regard the interaction between user/licensees and the persons involved with the development of the technology as crucial. If the users are not involved at an early stage developer runs the chance of developing an unusable or poor product with regards to operators' needs.

Operator 2 states, in accordance with operator 1, that the cooperation is vital to succeed. It is also preferred done at an early stage of the process.

4.5.6 Time horizon

Operator 1 does not state any strategic mindset other than that they use net present value calculations[41] to estimate profitability. This calculation favors profit volume in the near future, as it discounts profits in the long run. The foundation that the profitability potential is based upon does therefore not consist of a particularly long time horizon.

Operator 2 does not offer insights in the exact method of their profitability potential, but state that they on a general basis would like to see profits within two years. They also mention that this is somewhat dependent on the project size.

4.5.7 Free passenger-problem

Operator 1 states that they do not take the free passenger-problem into account when they make decisions regarding pilot projects. They base this statement on the fact that sponsoring a project consisting of technology development, they might be held accountable for substantial costs on the specific field, but they also take into account that the development can gain profits on other fields where they are partners. They also state that sharing of technology always has been the approach on the NCS in general.

Operator 2 states that they do not see this consequence as a problem. They base this on the fact that if the investment can increase the overall profitability of the field, they will always, in general, be willing to look at potential investments

4.5.8 Competition around technology and ownership

Operator 1 has not been willing to disclose much information with regards to how important this subject is. They simply state that when piloting of the technology is to commence, the situation around competition has been mapped and technology has been chosen. When it comes to the importance of ownership operator 1 has replied that this is not important for them as long as the technology works with accordance to the problem it is intended to solve.

Operator 2 states that the importance of competition around the technology is highly dependent on the costs of the operations the technology seeks to improve. If the technology seeks to improve costly operations, such as for example drilling, it is regarded much more important that competition

[41] Net present value calculations are made using the following formula: E (NPV) = $C_0+C_1/1+r+C_2/(1+r)^2+.....+C_T/(1+r)_T$, where E (NPV) are the estimated net present value. If this number is positive, the project should be profitable. For more detailed information regarding net present value calculations, Brealey, Myers & Allen (2006) can be recommended.

exists, than if the technology seeks to improve much cheaper operations. For the mentioned expensive operations they also state that it is common that professional considerations are made towards the maturity of the technology.

Operator 2 has replied that they regard rights to use the technology as much more important than the right to own and distribute the technology.

4.5.9 Other reasons?

The operators were also asked if they had individual opinions with regards to the high number of pilots that are reported delayed or postponed.

Operator 1 has answered that during the course of development unforeseen events may occur. Such events may be that the development changes course, that one wants to investigate other possibilities, with more. Such situations might influence. Another factor may be availability on the platform the pilot is intended for. If it is scheduled for a periodic shut-down this might affect the pilot. Such situations might be corresponding to pilot intended for drilling rigs.

Operator 2 states that the substantial amount of bureaucracy within the companies to some extent might influence technology development in a negative way. It is also suggested that a higher degree of “security addiction” is present in the petroleum industry than in other industries.

5. Results/Discussion

5.1 Contracts for pilot projects

Under the following headings the three contracts will be compared to one another, within the five topics that have been defined previously. Some important elements already reviewed in the presentation of the contracts in chapter 4 will be repeated, so that the reader does not have to go back in the text to understand the main points of the comparison. The contracts will be referred to as contract 1, 2 and 3 respectively, in accordance with the presentation in chapter 4. At the end of the discussion the balance in each contract will be discussed.

5.1.1 Rights to Technology

The rights to technology are somewhat different regulated in the three contracts.

The similarities are that all contracts are loyal to the rule that technology developed prior to the contractual relationship shall be the property of the originating company. This is however phrased a different way in contract 1, in comparison to the other two. It is here stated as a starting point that all information shall be the property of operator before exceptions are made. It is however stated as an exception that the rule does not give operator rights to information developed by contractor prior to the work. The starting point can therefore be seen as rather one sided in comparison with the other two, which do not start off with any party having all rights. Should there arise situations within the projects which is in the grey area of who has the property rights, this might be a subject of debate and negotiations in contract 2 and 3, but based on the phrasing used in contract 1, it would here seem logical that any situation not falling entirely into a defined exception from the main rule, would undoubtedly be within operators' rights. In comparison, the other two formats have as a starting point that technology developed prior to the contractual relationship is to remain the property of the originating company.

Contract 2 and 3 states that contractor shall have the rights to technology and information developed mainly on the basis of information contractor has provided the project with. The two respective formats use slightly different phrases for the two. Contract 3 use the phrase "*wholly or mainly*" while contract 2 only uses "*mainly*", it is however not likely that the difference has much practical meaning. One can quite easily interpret that "*wholly*" is within the circumference of "*mainly*" in contract 2. One can therefore most likely conclude that this statement bears the same meaning in contract 2 and 3, and that they therefore are similar on this point.

In contract 1 this is regulated differently. The contract as previously explained contains the definitions *system* and *units.* The contractor has here pre-defined units which they are to have the rights to. It is defined in the contract that all inventions and information developed in relation to these units is to be contractors property, unless inventions are made that covers the application of two or more units. If this is the case the rights shall be operators'. Instead of concentrating on which party that provided the information, the parties have here concentrated on what the invention or information is related to. This might be an advantage for the contractor if the operator has information that can further develop their units in comparison to the other two contracts. It will however be disadvantageous if developments of the entire system or developments that cover the application of two or more units are made, performed by and mainly based on contractor information. The rights will then fall to operator. With the same situation, but with the arrangements of contractor rights in contract 2 and 3 the rights would fall to contractor.

Operators' rights to own technology is quite different in the three contracts examined.

In contract 1 it is stated that all inventions; during the performance of the work, within the scope of work, covering the application of two or more units and also all inventions that are outside the scope of work, but mainly based on results of the project, shall be the property of operator. These rules are to be applied until the completion certificate for the contractual delivery is issued.

In contract 2 the operators do not seem to have direct rights of ownership to the technology. Their rights in this contract seem to relate more to *right to use*. This will however be discussed under the next heading.

In contract 3 it is stated that operator has the right to information or patents, wholly or mainly based upon information that operator has provided the project with. Operator also holds the right if the developments are part of the work defined in the scope of work.

It seems quite certain that operator has gained most rights in contract 1. In this contract operator is in many cases entitled to rights even if not contributing to the development at all. The only criterions for operator not to receive rights to technology during the project, seems to be if the development concerns only one unit of the system. Compared to contract 3, the operator here has to contribute to the development by information that the development is mainly based upon to receive such rights. Should the development however not be mainly based on operator provided material, but still be within the scope of work, operator still receives the rights. This means that in theory operator also in some situations can gain rights without contributing actively here. This statement is also interesting with regards to precedence. As earlier described contractor is in this contract entitled to ownership if the development is made mainly on contractor provided information. It is then possible that development can take place based on contractor provided material, but within the scope of work. The two statements are then in conflict, and the question of which party is to receive the rights then arises. It is however believed that operator's rights have precedence since written first in the contract. Another possibility is sharing the rights between them by using another statement in the contract which is discussed beneath.

While none of the contracts 1 or 2 outlines the possibility of sharing ownership, contract 3 states this as an option if both parties have contributed to the development. The contracts also states that in such a situation ownership and costs are to be shared equally. Such an agreement combines well with the thought of cooperation on equal terms, but as mentioned earlier, this contract is for an actual field delivery and does not regulate the question of exclusivity either. One can therefore assume that this contract contains more mature technology than contract 1, and therefore the chance of developing new inventions during the project may not be that imminent.

5.1.2 Right to use of technology

The rights of use also logically have relations to the rights of ownership, which has been discussed above. The parties of course have the right to use technology which they are entitled to own. The interesting aspect here is however which rights they have to use the technology which the opposite party owns.

In all three contract formats it seems that operator has managed to retain user rights to the technology they need to ensure competition around tendering, and also operation of the delivery, without additional costs for licenses.

It is in all three contracts stated that contractor is to give operator *a royalty-free and irrevocable* license to patents and information that has developed prior, or during the contract, and that has relation to the contractual delivery. Contract 1 and 2 also states that these rights shall be *non-exclusive* in the sense that contractor can give similar rights to other companies which they might cooperate with. Exclusivity is however not mentioned in contract 3. Since it is not mentioned either way, this can imply that *exclusivity* has no relevance in this contract. One can therefore assume that the technology in this contract is regarded more mature than the others, and also that sale of the technology possibly has been agreed with other parties. This would mean that exclusivity already has been broken, and therefore is irrelevant. Contract 2 has an additional phrasing with regards to the user rights. It is stated that the license also is to be *non-transferable.* It is somewhat uncertain why this phrasing has been added, since the contract states that also co-venturers within participating operators' license are to be given rights. It is possible that the phrasing is meant to limit the operator from giving user rights to competing contractors.

In contract 3 it is stated that the license is to be given *world-wide,* while in contract 1 the license is given only in relation to the specific construction in the contract. It is however limited where operator is entitled to apply their rights of use. In contract 1 and 3 the license is only applicable as long as the technology is concerned with, procurement, design, operation, maintenance, repair, extension, modification and rebuilding of the contractual delivery. The phrase, *world-wide* in contract 3 is possibly then meant to be applied if operator or other companies within the license have similar construction where the user rights can be applied.

In contract 2 the user rights are limited to the extent of *normal operations*[42]*.* This is done so that operator has limitations on further commercial exploitation of the project results, such as sale of the technology to other companies , or transfer of technology to branch companies which might have a different field of business.

The contractor also has retained some rights of use within the contracts.

In contract 2 the rights to ownership mainly falls to contractor. This means that contractor also will have right of use to the information and inventions developed during the project.

In contract 3 it seems that contractors' right of use is mainly related to developments where contractor also is entitled to sole ownership or shared ownership. The contract does not state any exceptions where contractor is to be given additional rights of use.

In contract 1 it is however further defined where contractor is to receive rights of use. It is here stated that in similarity to operators' right of use to information and inventions developed by contractor, contractor shall likewise have the right to a royalty free, irrevocable and non-exclusive license to use inventions or information that the operator has ownership to. This of course can be seen as quite balanced, but it is nonetheless important to take into account that the technology applied in this contract largely has been developed by the contractor prior to delivery.

As argued previously, *right of use* is a very important point for both contractor and operator. The operator will seek to limit contractors' rights to charge them with additional royalties and license fees. They do not want to pay for the same thing twice if they in addition have been part of the development by financing. If possible operator also wants exclusive rights of use, so that they can

[42] *Normal operations* have been defined in the presentation of the contract in chapter 4.

gain a competitive edge towards other operators by controlling the technology, and possibly also exploit other commercial aspects. It is also important for operator to secure technical information with regards to procurement, design, operation, maintenance, repair, extension, modification and rebuilding. Should this not be secured, operator will become very dependent on the specific contractor also after the contractual relationship. Logical enough, operator will seek to avoid this.

Base on the discussion above it is therefore possible to conclude that the right to use the technology developed, has a much wider circumference for the operator than the right to intellectual property.

5.1.3 Finance

The three contracts all have different compensation formats.

Contract 1 is compensated with *provisional sum.* The provisional sums are tied up to project progression milestones, and at each milestone the contractor receives a certain percentage of the payment. The percentage received is a little higher than the actual work performed to ensure contractors cash flow. This compensation format places most of the risk on operators' side. Contractor should in theory only be exposed to risk through guarantees, delays and wrongful construction, which lie within their control sphere.

Contract 2 does not have a compensation format like the other two, per se. As no one actually is performing a scope of work on behalf of another party, like in contract 1 and 3, this contract seem to have more the character of a Dutch treat. A budget is agreed upon and the parties contribute according to their shares of the project. The budget can be increased if the parties agree that this is desirable.

Contract 3 is compensated with a *fixed price.* This compensation format places most of the risk on contractor's side, as the operator only has agreed to compensate the contractor with a pre-determined sum. To reduce some of the risk for contractor, a liquidated damages clause has been agreed. This clause states that if the project is delayed or wrongfully constructed, due to circumstances which lie with the contractor, contractor cannot be penalized by more than an agreed sum, or percentage of the project costs. Some initial testing was also done prior to installation on operators' expense. This also contributed to the contractors' willingness to accept a fixed price contract.

With regards to risk one can therefore conclude that risk is best avoided by the contractor in contract 1. Within contract 1 the contractor has incentives linked up to reaching the milestones quickest possible to receive compensation, while in contract 3 the main incentive is to minimize cost so that they can yield highest possible profits of the fixed price. In contract 2 the agent performing the research on behalf of the participant will have incentives to keep costs down according to his own share of project costs.

Due to the compensation format of fixed price, contract 3 is also on this matter showing signs that the contract consists of a more mature technology. Even though some initial testing was paid for prior to installation it is believed to be rare that contractors accept fixed price compensation with regards to development projects.

Incentives of higher order have not been detected at a very large scale within the contracts examined. Cost breakdown structure and bonuses has however not been revealed to the author, but based on statements from the coadjutant contractor the trend on the NCS is still south in the pyramid[43].

5.1.4 Long-run earnings

Long run earnings have much of the same elements in the three contracts examined.

Within contract 1 and 3 contractor earnings are related to profits from the EPC-contract agreed. This is however not the only earnings for the contractor. Earnings are also related to the fact that the technology is tested and possibly also qualified for use. If the pilot is successful contractor is also equipped with a new product. This can give contractor a competitive edge towards other contractors and can also be sold on the free market. Provided success, the pilot serves as good marketing towards other potential buyers. This is important in a market known for its' conservatism.

In contract 1, where a contract for implementation on the actual field is imminent the project gives contractor important experience towards project execution of the contractual delivery. This has to be taken into account by operator when the EPC-contract for the actual implementation is to be awarded.

The earnings for contractor in contract 2 do not involve direct profits due to the contract, as in the other two. Here the earnings are more related to testing and development of technology without having to take all the financial risk. Previously mentioned advantages as; a new product and good marketing, although can be applicable in contract 2 as well.

Operator on the other hand has earnings in regards to improved oil recovery and reduced CAPEX and OPEX. All earnings mentioned will lead to increased profits.

[43] See 2.1.5 Incentives of higher order.

In contract 2 the operator has earnings in form of knowledge and user rights to whichever technology or information developed. This can be obtained by only a relatively small part of the funding (12, 5% in the contract examined).

In contract 1, operator in accordance with contractor, has earnings in form of experience gained from the pilot. Lessons learned and weaknesses detected during the pilot can be applied and fixed during the implementation on the actual field.

In all three contracts operator, by being part of the project, has the opportunity to influence the development. This means that operator might get a solution that is somewhat tailored towards their needs. This is considered a highly plausible outcome, since operator is the most likely buyer. Contractor will therefore listen very carefully to operators' needs.

5.1.5 Ownership to hardware

As the contracts show there are differences in the regulation of ownership to hardware. Contract 1 and contract 3 contain big deliveries, and in contract 3 the delivery is in addition for use at the actual field. The contractual object therefore has a value after completion and testing. In contract 2 and 3 the delivery can therefore be seen in comparison to buying a product. Buyer will then logically enough be entitled to the product. Contract 2 does not involve a direct delivery in opposition to the other two. In addition contractor here holds the property rights to the hardware. This is a much smaller project and contractor is also the biggest single financer (except for Demo 2000 which funds an equal share[44]). Since contractor is biggest financer it seems just that the hardware shall fall to them.

On a general basis I have been informed that ownership to hardware often not are considered very important with regards to pilots. Sometimes the pilots have fulfilled their use once testing has been completed. If operator, for instance do not have user rights elsewhere than the actual pilot location, the materials can be the only value the object has. It is then worth mentioning that the demobilization and removal of materials can be costly. The criteria often deciding whether or not the ownership to hardware is worth negotiating for, therefore is; the value the object has after completion.

[44]It is however doubtful that Demo 2000 has special interest towards the hardware after the project completion. In any case, they would not let their interest jeopardize the project.

5.1.6 Balance within the contracts

It is hard to compare the contracts to one another, as the starting point and conditions in each contract are quite different. Some tendencies with regards to balance can however be seen.

In contract 1 the technology used has been developed by operator during a long time span. It would therefore seem fair that they retained a substantial amount of the potential upside, although it is quite possible that they have made profits on parts of the technology also prior to this contract. The starting point of the IP article in the contract, is a few exhaustive paragraphs that states that all information and inventions shall be operators', with a few exceptions. This point seems a little unbalanced with regards to agreements in the other two. At the same time it is important to take into account that operator, in this contract, is funder of the whole project and also assumes almost all risk due to the usage of a provisional sum compensation scheme. Nonetheless it might seem more balanced to secure user rights to the technology, but leave all ownership of the units to contractor.

The clauses regarding the right to use seems more balanced. From the contract it seems that operator is to be given right to use the technology owned by contractor and vice versa.

As far as aligned interests goes, this is mainly tied up to a successful implementation and testing of the pilot. Otherwise the operator has superior interest to maximize the value of the field, and thus keep development and operational costs low. The contractor has no incentives tied directly to the field. Incentives for contractor will therefore concern maximizing project revenue in relation to project costs. The contractor has also managed to give operator incentives to choose them as supplier with regards to implementation on the actual field. This has been done by demanding fees for constructions concerning their patents if they are not awarded the EPC-contract.

Contract 2 seems fairly balanced. The owners contribute by their respective shares, but contractor is the single biggest bearer of costs. Contractor is then entitled to patents and ownership, but operator is entitled to user rights and further development of project results. This arrangement seems fair with respects to the funding arrangements, especially if contractor in addition is to be responsible for manpower.

The main goal here is of course to develop technology, but the parties have also extended their cooperation by additional agreements. The contractor has agreed to prioritize cooperating operators in tenders regarding the technology developed, while operator guarantees that contractor will be invited to tender or prequalify for tenders involving the technology developed. This point also seems as a balanced agreement.

Contract 3 has applied some of the rules within the standards (NF and NTK). The contract is fairly balanced with regards to information and inventions. The main issue is who contributed with the information the development mainly was developed upon. The word mainly can be subject of discussion and interpretation, but it would be logical to assume that this would be interpreted to be more than 50%.This rule is mirrored towards both parties. The only exception is if the information or invention is part of the scope of work in the contract. Should this be the case the rights would seemingly in any case fall to operator. The rights to ownership are in other words unbalanced with regard to this specific situation. The two parties have however agreed upon an arrangement that states that if no party can claim rights within the previously mentioned clauses, the two sides will share the related rights and costs. How often such a rule is applied in practice is uncertain, but such a scenario is not mentioned at all in the other contracts, and most be considered a step in the right direction in relation to balanced terms.

While in this contract the contractor seem to have more rights with regards to technology, it is important to take into account that the contractor also has assumed much more risk than in contract 1, due to the fixed price compensation. This should logically place more of the upside in contractor hands. A liquidating damage clause has however been agreed, but it is unknown how big cost overruns can get before the “cap” is reached. Nonetheless this contract seems more balanced than contract 1.

5.1.7 Summary

After reviewing the contracts it seems that operator in general gains the most favorable terms in contract 1 and 3. One however has to take into account that operator also here funds the project. In contract 3 the terms are nonetheless more favorable for the contractor than in contract 1, but contractor has here also consumed more of the risk due to the used compensation scheme. In contract 2, contractor seems to have most favorable terms, but here contractor is also the single biggest funder.

Based on the three contracts examined it seems that favorable terms often are related to financing and risk placement. Knowledge towards technology is however also of course important, but it seems natural that the biggest funder and the consumer of most risk also should have the best terms. What the contracts may not take into account is the time and funding these developments has demanded from the contractor prior to these contracts. This should in an ideal situation, might have a bigger impact than it seems to have in contract negotiations. Operators’ should therefore maybe be a bit careful to make too much use of their bargaining power towards ownership of the technology. This might be profitable in a short time span, but might lead contractors to see technology development as less profitable in the long run. Should this happen, operators will lose potential sources to enhanced technology.

5.2 Decision strategies at operating companies

In this section a further analysis of the operating companies' answers will follow. Are the answers according to theory, or do the operators have a diverse perception with regards to the theory examined? Why do the operators act the way they do? These are some of the questions which the discussion seeks to enlighten.

In accordance with theory the oil companies seemingly make initial calculations based upon economical defensibility on a specific field. If such calculations are found to be non-profitable, they take into account that the technology might be useful on additional fields. They however admit that this complicates the process and may decrease the chance of a pilot. This might be due to communication difficulties with fields abroad, or that decisions regarding multiple fields on an international level might demand sanctions of individuals higher up in the chain of command. Such sanctions might be more difficult to retain.

The voting rules within licenses are according to theory problematic. This has however been rejected by the oil companies. Since decisions seems to be made mainly on calculations on specific fields alone, it is plausible that decisions that has negative profitability on a given field alone, but positive if seen in respect to multiple fields, are rarely made. If this is the case minor fractions within the licenses will have no incentives to stop projects, as they will yield profits from the technology as well.

Interference with KPIs might be problematic if not adjusted according to factors that might influence. The oil companies however state that these are adjusted to circumstances that might affect them. Even if KPIs are suspected to have negative effects it is therefore difficult to conclude in opposite direction of the answers from the operating company.

Personal incentives, seems to be present in a very minor degree based on the answers. One of the reasons might be that it is difficult to make target figures and measure the employees' effort with regards to technology development. Another aspect of this is that piloting and technology development is uncertain and risky, and a successful investment can be hard to predict. When there are no personal incentives other than internal honor and respect, the employees might be inclined to be risk averse. It is highly unlikely (neither stated by themselves) that the oil companies operate with direct personal penalties for unsuccessful developments, but it is thinkable that individuals might lose internal respect, if in charge of such a project. Based on such a rationalization the potential upside (honor and respect) of development projects might be seen as too small by employees compared to the potential risk (loss of honor and respect, and in worst case; degradation of position). As a result they might turn down development projects, if not an extremely high probability of success is present. A high degree of certainty again demands testing, and testing demands funding. If the developer then lacks further funding, the technology development might be in a stalemate.

Champions within the organization are accordance with theory considered important by the oil companies, especially with regards to technology development. It is however somewhat difficult to impel more champions in the organization. A step in the right direction might be to create a culture for acceptance of failure with regards to development projects, at least to some extent. This would probably make it easier for individuals to “stick their neck out” with regards to specific projects, and hence might contribute to create more champions with ownership to the technology within the organizations.

As assumed the operators regard user involvement early in the process as a very important success criterion with regards to technology development. This ensures both user relevance and that operator is familiar with the technology at an early stage of the process. It also gives the operator the opportunity to influence the development, so that they might get a solution which is tailored towards their needs.

When it comes to the question of which time horizons the oil companies base their decisions upon, the suspected short term horizon has somewhat been confirmed, as the two operators state that they apply net present value calculations, and preferably wants profits within two years respectively. Net present value calculations are however mainly considered a model for usage to investigate profitability of specific investments, and thereby can be a good tool if future cash flows can be predicted with certain accuracy. The model nevertheless has limitations, as it does not take into account the competitive edge experience with enhanced technology yields towards securing new licenses both in Norway and abroad, and the advantages knowledge within the technology may offer. The net present value calculations may also be inaccurate since future cash flow may be hard to predict due to potential uncertainty around the technology. Another problem is the long time span from idea to commercial penetration of the market in the energy and petroleum industry. With an average time for commercial penetration of over 30 years (Mckinsey), it would seem that other models which take into account future cash flow in more favorable way could serve development projects better than the standard present value calculations.

The free passenger-problem relates to the fact that small percentage owners may gain user rights or owner rights to new technology even if their monetary contribution is low. This may be seen as unfair to companies with a higher owner percentage and therefore higher cost burden. The oil companies states that this is not taken into account when such decisions are made, since development of technology can secure them profits on other licenses where they are partners as well. Furthermore they state that sharing of technology has been the approach on the NCS. If this is accurate information it is considered very positive, since enhanced technology may increase recovery rate, and if the technology is shared this will be the effect for all fields involved. With regards to the NCS this means increased revenues for the government due to taxation, and hence increased revenues for the Norwegian society. It is however suspected that this is taken into account by some operators, but apparently not the operators which have answered the questionnaire.

Competition around the technology in question is according to theory, an extremely important factor for the operating companies. While operator 1 avoided answering this directly, operator 2 has to some extent admitted that this is an important factor, especially when involving costly operations. This might serve as a bottleneck for development in some situations. If the developer happens to be a contractor, and the technology is cutting edge and monopolized by the contractor, it is likely that the contractor will be reluctant to share the technology with other contractors, just to secure competition for the operator. The comparison of the contracts in headings 4.1-4.4 however showed that this might be done by revealing the system, but not the technology behind the specific parts of the system. This can be interpreted as a way to ensure both parties’ interests.

The ownership to the technology has been signaled, by the operators participating in the questionnaire, to be of less importance. The examination of the contracts however showed that operator has interests towards ownership, but it seems that this commodity has been forsaken to some extent, to retain rights of use, and to secure that an actual agreement between the parties takes place. To forsake some of the ownership rights is believed to be vital, especially if contractor is the developer of the technology, to secure that contractor actually agrees to the terms. One might also see the contractors’ bargaining position as somewhat increased during recent years, as there is a bigger variation of operators on the NCS today, opposed to earlier times. This leads to contractor having increased “options of choice” when negotiating with the operators. This might alter the outcome of contract negotiations, as seen in the contract presentations, as different operators might operate with different terms.

The questionnaire also included a question where the operators were allowed to speculate freely on the reasons towards the delays and postponements of pilot projects. Reasons towards change of plans and availability of test location were provided by operator 1. These topics might be difficult to take action against, as adjustments to newly discovered field requirements are vital in the petroleum industry. The scarcity of test locations is likely due to the high business activity within rig rental, and high oil prices. If such economic cycles are to be made none correlative with technology developments, one would probably have to invest in costly test facilities where technology could be tested against artificial conditions. The profitability of such an investment is on the other hand hard to calculate, as the economic cycles is somewhat hard to predict.

Operator 2 stated bureaucracy and security addiction as potential reasons. Bureaucracy has an important function towards securing that processes are carried out in the manner they are intended. On the other hand it might lead to a considerable slower and more difficult decision process for big companies with many employees. This is the case for most operating companies. This can however be counteracted if special divisions for technology development are created and these in turn are given, or put in close relations with decision authority. It is of course difficult to possess cutting edge knowledge towards all technology presented to the company, but it is believed that this might be solved through rental of consultant services if special professional considerations are needed.

The security addiction relates more to the state of mind the company has. It is believed that this might be counteracted if a culture for acceptance of failure, to some extent, is created within the companies. This is because it is regarded as a rather utopian idea that all development projects will be huge successes, but to have a certain acceptance for error and a fraction less risk adverse behavior is believed to have a positive impact on technological development as a whole. This is underlined by the fact that government subsidized programs, such as Demo 2000, has been regarded to quite successful.

6. Conclusion

This thesis presents three different pilot project contracts and questionnaires answered by two different operating companies. The objective of this thesis has been to map potential pilot/development project stoppers, with regards to the balance in the contractual agreements, and in the operating companies' decision processes. Other reasons might also exist, but hopefully the thesis offers insight on the focus areas.

The findings of the thesis suggest that there are individual adjustments in different pilot contracts. It seems that the adjustments can be a consequence of size of the project and maturity of the technology. If the technology is considered to be cutting edge and thereby have a low degree of maturity, operators seem more determined to negotiate harder for ownership. If the technology however is considered to be more mature, it seems that an operator will focus more on the user rights. This seems to be done by negotiating for worldwide royalty- and license free rights to use.

The balance in the contracts also seems to differ somewhat depending on which operator (and probably also contractor) which is involved. Operator seems to set more demanding terms with regards to ownership if consuming most/all of the risk (for example thorough reimbursable or provisional sum compensation schemes). In opposition contractor seem to get more balanced terms to ownership of technology if they assume parts of the risk (with reference to fixed price compensation with a liquidating damages clause). It does however seem that development costs of the technology prior to contract agreements could be taken more into account during negotiations. It seems that some of this value is lost to the contractor during negotiations. This might be a result of the asymmetric bargaining power that might exist between the parties.

It is believed that operator should be careful of demanding too much ownership of the technology if the technology has been developed by operator, even if they should find themselves in a superior bargaining position. This can lead the contractors to see technology development as less profitable, and thereby reduce their willingness to invest in development. If such a situation occurs, the operators will lose a valuable source of new technology.

The findings of the thesis with regards to decision strategies suggest that some of the topics discussed might quite possible be factors that inhibit pilot projects. On the other side the operators stated some opinions in the questionnaire that were a little surprising according to theory. The fact that the operators stated that ownership to technology is not regarded important is somewhat surprising. It is also quite surprising that champions within the companies are stated to have such a high importance. This suggests that personalities within the companies might be just as important to development, as organizational mindset and calculations. Problems stated by the Extraction committee with regards to the voting rules within the licenses and the free passenger-problem has categorically been rejected by the operators.

It however seems that problems related to short time horizons on profit calculations, profit calculations made on multiple fields, a high degree of risk aversion in the oil companies and a strong need for competition around the technology might slow development down, and pilot projects along with it.

It is therefore believed that better communication and cooperation between the oil companies across the licenses, would help the companies of comparing costs and profits on multiple fields to see if a specific technology could be profitable to the fields in connection.

Long lasting cooperation between contractor and operator might reduce operators need for competition, but the chance of opportunism by contractor with regards to technical monopoly will then be present. This makes this problem hard to solve.

At last it has been suggested that the oil companies create a culture for innovation and with it a certain acceptance for failure. This makes it easier for employees to “stick their neck out” and hopefully would create more champions within the organization. Such a measure would also reduce some of the risk aversion within the companies, and hopefully contribute to a shorter time span from idea to commercial penetration. By implementing Demo 2000 and Petromaks the government has contributed to reduce some of this risk and probably also some of the risk aversion. As the programs were started only approximately 10 years ago, and the average time from idea to commercial penetration is assumed to be around 30 years, it is yet early to say which influence these programs has had on the time frame. It is however highly plausible, that they also here have contributed positively.

It is not believed that this thesis provides conclusive answers on, or even enlightens all potential problems with regards to development or pilot projects. To do this, both more and much more extensive research is needed. The thesis has however hopefully contributed to enlighten some of the aspects, and thus hopefully can be useful to persons who wish to learn more about this topic, or similar ones.

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7.1 Appendix nr. 1

The following questions were included in the questionnaire sent to the different oil companies. Where a questions has an additional i) marking, further information has been given to clarify the question.

1. At which basis is the decision to finance a pilot project made?

2. Is it regarded important that end user/license holder(s) is involved in the actual pilot project?

3. How important is it that competition around the technology is present?

4. How important is it that end user has patents/ownership to the technology being used?

5. Which factors has to be in place to ensure success for the pilot/technology development, and that one can make decisions towards using the technology in coming projects?

6. Which time horizons does one base the decision upon? Does on base the decision upon the whole life-cycle of the project or are effects in imminent future favored?

7. Is the decision based upon the fact that the technology might have an effect on multiple fields, or does one have to defend the costs of the project on the specified field alone?

8. How is the free passenger problem weighted in such decisions?
   i) The licenses of often consist of different compositions of different companies. It is therefore thinkable that other owners than operator on the pilot field might have advantages of the new technology, even if they possess a minor percentage of the license, and as a result also a minor fraction of the costs. Furthermore, they might not be an active part in the technology development.

9. Are the voting rules within the licenses considered a problem towards development/pilot projecting?
   i) Hereby that small ownership groups within the license do not see the long term value of the project and therefore votes against it. For example if the small groups consist of companies which do not have similar owner interests in other fields.

10. To what extent does involvement of “champions” within the organization have significance for the initiation of such projects?

11. Which incentives do decision authorities have towards green-lighting development/pilot projects?

12. Given a significant internal mobility; will the winnings of such projects be credited to the initiator(s), or is it possible that punishment due to increased downtime will occur, and that they might be transferred when the winnings of the project is noticeable? How the priority of development/pilot projects affected by the company’s KPIs?

13. According to the Norwegian government, a large number of pilots on the Norwegian continental shelf are reported delayed or postponed. Does the company have any additional viewpoints towards the reasons behind such a situation?

7.2 Appendix nr. 2

The graph shows the time frame for industrialization of various products. As seen in the graph, the industrialization time in the energy and petroleum industry is assumed to be over 30 years, based on a study of 15 different cases.

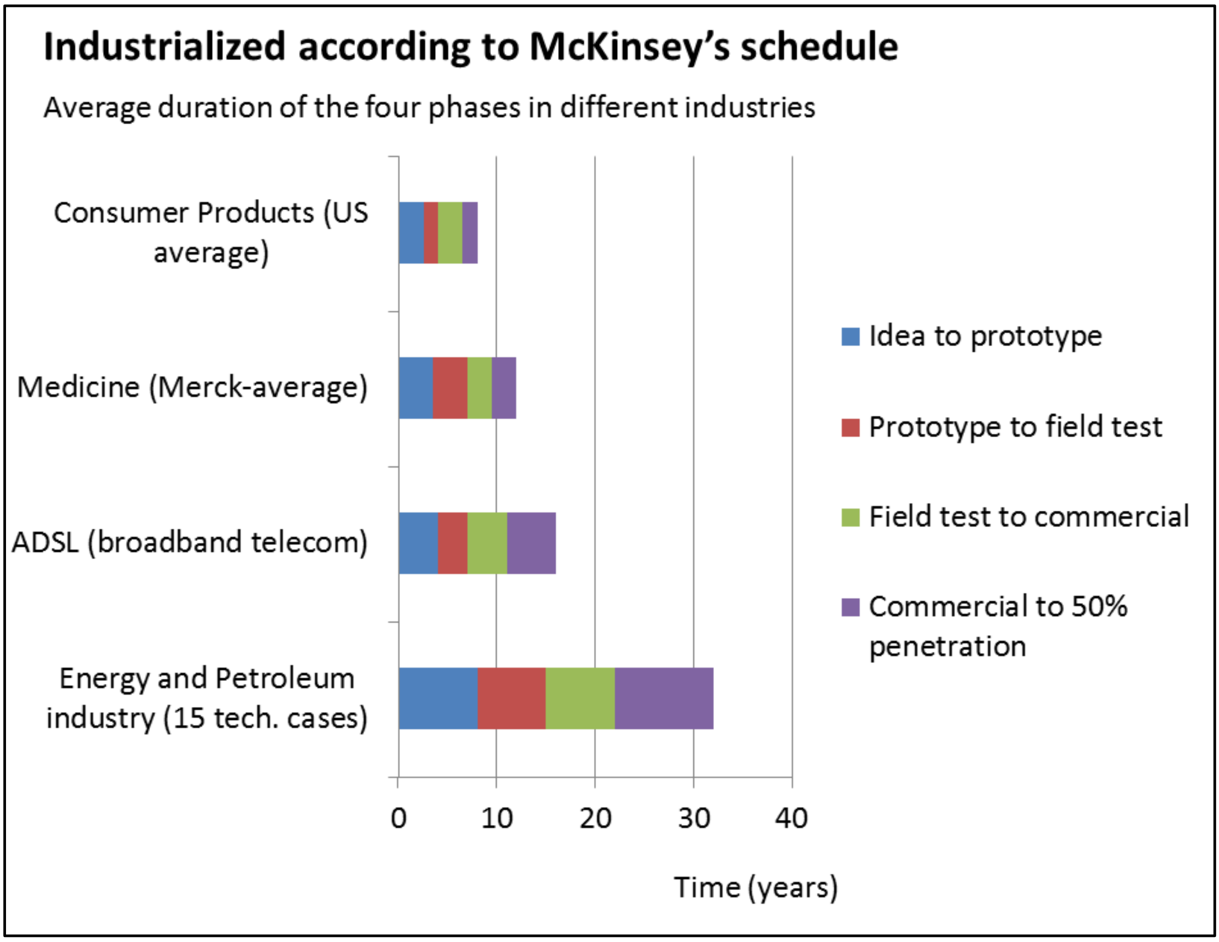

Figure 7 Industrialized according to McKinsey's schedule (Source: Coadjutant contractor company)