NTNU – Trondheim
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Effects of early supplier involvement on the utilization of suppliers´ knowledge

Using the example of field development
projects in the Norwegian petroleum industry

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Project Management
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Master's Thesis in Project Management

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Abstract

Integrated oil companies face major challenges in their businesses: While the world's demand for oil is rising, easy and cheap field exploitation is declining. In particular, the average volume of oil from the discovered oil fields in the Norwegian continental shelf is decreasing. To face these challenges, oil companies need to explore inconvenient sources like oil sands, ultra-deep-water fields or fields in arctic conditions by using specialized technology. Innovation and technological development are also necessary to improve oil recovery in maturing fields and more difficult reservoirs and to make these sites profitable. Every new development of an oil field and the activities within present unique difficulties and thus require special know-how and technology. Therefore, integrated operators must develop high levels of technology for the different needs of their field development projects as their area of action becomes even more international, which also demands a greater variety of know-how.

This study explores ways that operators can resolve these difficulties by intensifying collaboration with their suppliers. The effects of involving suppliers in the early front-end phase of field development projects on the utilization of suppliers' knowledge are analysed in detail. The research results are derived from a literature review on the one hand and analysis of research interviews with industry practitioners on the other.

This study provides valuable new insights for both academia and industry practitioners. In particular, it shows that involving key technology suppliers early in the evaluation and concept planning of newly discovered petroleum fields can lead to a more efficient and effective outcome of field development projects because the know-how and expertise of the suppliers is used more efficiently. This study also shows that the concept of early supplier involvement (ESI) currently is not being used in Norwegian field development because of industry-specific factors. In particular, the irregularity and rather short-term cooperation of project-organized industries like the petroleum industry complicate the achievement of the long-term and high-involvement relationships necessary for ESI. Therefore, this study also provides a model for overcoming the industry-specific difficulties and using ESI in field development projects to enhance the utilization of suppliers' know-how.

Acknowledgment

This master thesis is written at the Department of Industrial Economics and Technology Management at NTNU and concludes my masters degree in Business Administration and Engineering on the one hand and on the other hand my semester abroad in Trondheim, Norway.

Several persons have been involved in this project and I am very grateful for all help and support given. Especially, I would like to thank my supervisor Tim Kristian Andreas Torvatn for contributing with guidance, feedback and professional knowledge. Also I want to express my gratitude for his support during my semester abroad and in particular for giving me the opportunity to write my master's thesis at NTNU in Norway.

I would also like to thank my informants of the several companies in the petroleum industry for their participation in my research and their valuable insights on the practitioners' perspective on the research topic.

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Abbreviations

EPCI	Engineering, Procurement, Construction
ESI	Early Supplier Involvement
FEED	Front end engineering design
KPI	Key Performance Indicator
NCS	Norwegian continental shelf
NPD	Norwegian Petroleum Directorate
R&D	Research and development
RBV	Resource based view
TCE	Transaction cost economies

1 Introduction

In this introduction, I present the motivation for examining the research problem of this thesis and how this problem statement translates into research questions and goals for my study. Also, I outline the research approach and the limitations of the study.

1.1 Motivation

A study of AT Kearney (Forrest et al., 2011) on integrated oil companies shows that these companies face major challenges in their businesses: While the world's demand for oil is rising, easy and cheap field exploitation is declining. To accommodate demand, companies need to exploit inconvenient sources like oil sands, ultra-deep-water fields or fields in arctic conditions by using specialized technology. Innovation and technological development are also necessary to improve oil recovery in maturing fields and more difficult reservoirs and to make these sites profitable. Every new development of an oil field and the activities within present unique difficulties and thus require special know-how and technology. Besides these production-oriented issues, governmental regulations increase operational constraints on oil and gas projects and activities.

Additionally, a research paper on the Norwegian petroleum industry (Sasson and Blomgren, 2011) reports an observation that especially presents new challenges for the Norwegian petroleum industry: While the percentage of field discoveries per exploration has risen strongly since the first field development in 1969, the average volume of the discovered fields has decreased. Therefore, Sasson and Blomgren conclude that Norwegian field operators have to address three major issues in the future to economically develop smaller fields:

- improving the rate of recovery;
- increasing the number of production wells; and
- opening new areas to oil and gas activity.

To meet these challenges, fully integrated operators must develop a high level of technology for the different needs in their field development projects while their area of action simultaneously becomes even more international, which also demands a greater variety of know-how. How can fully integrated operators respond to these challenges?

Sasson and Blomgren (2011) point out that the solution to improving the recovery and to developing smaller fields is that these activities have to become more cost-efficient and flexible. Consultants of Booz & Company (McKenna et al., 2006) point in a similar direction

in a research paper on project execution in the oil and gas industry. The researchers think that redesigning the project framework and further outsourcing and cooperating with their suppliers are necessary for handling increasingly complex development projects while improving the use of scarce internal resources.

Besides these general tasks, there are specific project management challenges in field development projects of the Norwegian Oil and Gas industry. In 2013, the Norwegian Petroleum Directorate (NPD) published a study titled "Evaluation of projects implemented on the Norwegian shelf" that analysed field development projects approved between 2006 and 2008 with a scope exceeding NOK 10 billion. The report shows that avoiding cost and time overruns are major challenges for development projects in the Norwegian Oil and Gas industry. Some projects overrun the estimated implementation time and cost by more than 100%, while other projects stay in the indicated uncertainty range of time and cost. The report found that besides the crucial project management factors inherent in any project, the most important factors for successful project management in development projects are "high quality work in the early phase" and a "clear contract strategy" (Norwegian Petroleum Directorate, 2013). Overall, this situation leads to problems.

1.2 Statement of the problem

The motivation statement explains the interest in and practical demand for an explorative study on the effect of collaboration between petroleum operators and suppliers. In particular, the practice of drawing upon suppliers' knowledge in the early phase of field development projects in the Norwegian petroleum industry suggests a research area that is of interest to both academia and practitioners in the industry. Additionally, the concept of Early Supplier Involvement (ESI) as a form of vertical collaboration within the supply chain has been increasingly researched in both academia and business management circles in the last years. The outcome of applying early supplier involvement in various line-organization-oriented industries' new-product-development-projects has been researched frequently but has often yielded different results. Academics have not yet agreed about whether involving suppliers' early has a positive effect on the outcome. Therefore it is interesting to explore the effect of ESI on the effective utilization of suppliers' knowledge in the project-organization-oriented petroleum industry. The statement of the problem for this study follows.

Statement of the problem

Analyse and evaluate whether and how ESI as a form of vertical collaboration affects the utilization of suppliers' knowledge in petroleum operator's field development projects using the example of the Norwegian petroleum industry.

1.3 Research questions and goals

The aim of this research is to explore the problem in ways that are relevant to academia and practitioners equally and that contribute new insights on the topic. To do so, I have developed the following research questions.

R1: How does ESI interact with the utilization of suppliers' knowledge in operator's petroleum field development projects?

R2: How can ESI be used in petroleum field development projects to enhance the utilization of suppliers' knowledge?

The goals to accomplish in this study can be summarized in the following way.

1. Research the status of operator-supplier collaboration in the Norwegian petroleum industry's development projects.
2. Investigate the positive/negative effects of ESI on the use of knowledge and know-how in projects.
3. Identify areas and requirements for embedding ESI in projects so operators can benefit the most from suppliers' knowledge.
4. Make suggestions and recommendations for embedding ESI in the Norwegian petroleum industry's projects.

The goal, 'Research the status of operator-supplier collaboration in the Norwegian petroleum industry's development projects', is covered in the literature review and the analysis of the research interviews. The second goal, 'Investigate the positive/negative effects of ESI on the use of knowledge and know-how in projects', is covered in section 3.5.3 and in the discussion section of the first research question. The third goal, 'Identify areas and requirements for embedding ESI in projects so operators can benefit the most from suppliers' knowledge, is covered in sections 3.5.4 and 3.5.5. The last goal of the thesis, 'Make suggestions and

recommendations for embedding ESI in the Norwegian petroleum industry's projects', is covered in the discussion of the second research question.

The practice-oriented approach of the problem statement makes this study of use for several different groups. The study is interesting for the petroleum industry's operators because it seeks answers to the industry's challenges that are outlined in the motivation statement. Furthermore, oil and gas industry's suppliers can use the study to review their role and contributions to field development projects and to consider the worth of long-term relationships in the supply chain. This study will also be interesting to companies of other industries because the effective utilization of suppliers' knowledge in complex projects is a broadly relevant topic, especially for high-technology industries. For academia, this research provides an explorative examination of the transmission of the ESI concept from the new-product-development environment in line-oriented industries to a complex irregular project-oriented industry.

1.4 Approach and Limitations

In this study, I used an exploratory research approach to elaborate upon the research statement. Therefore I conducted a broad literature review on the concept of ESI and the underlying fields of outsourcing, buyer-supplier relationships, cooperation and suppliers' capabilities. Also I reviewed literature on knowledge management and knowledge as an asset. This gave me a broad understanding of the links and coherence of the different theoretic topics and a conceptual platform from which to approach the research interviews. To ground the answers to the research questions in data, I studied practitioners' approach to the theories and models through semi-structured interviews with participants from oil operating and supplying companies of the Norwegian petroleum industry. Eventually, I answered the research questions in the discussion and conclusion parts of the study by analysing the findings of the literature through the insights I gained from the research interviews.

This approach has some limitations. Firstly, the research problem is approached from the operator's perspective. While it also would have been possible to approach the research problem from a supplier's perspective, a neutral perspective seemed to introduce too much complexity and scope for this thesis. While that does not mean that suppliers cannot derive any value from the work, it seemed more interesting to me to explore the research problem from the supply-chain's focal company perspective. Secondly, I have taken a relatively comprehensive approach to the literature review, including the most relevant literature and

research papers on the main subject of ESI and closely related topics. However, I do not intend to imply that my selection is complete, especially considering that the concept is relatively new and is based on multidisciplinary academic fields. Also, it is possible that research papers or books were or will be published after I had finished my review. Thirdly, the approach to data generation through qualitative research through semi-structured interviews leads to limitations. Even though I carefully selected the companies and interviewees as well as operators and suppliers, the validity is limited because the small sample of eight interviews. The further limitations of the research method are mentioned in the methodology section.

2 Methodology

This chapter describes the general research strategy of the study and the methods used for gathering information. Firstly, the general research strategy is described and the methods used to gather data from literature and practitioners are explained. Then, the limitations specifically caused by the choice of methods are presented.

2.1 Qualitative research strategy

The objective of the statement of the problem is to identify key issues and examine key variables, which leads to the conclusion that the purpose of the study is exploratory. Achieving the goals and elaborating upon the statement of the problem require studying the subject in depth and from an academic as well as a business practitioner's perspective. The needed data to study the subject in-depth are available mostly in documents or transcripts. Also the general approach to answering the research questions was to arrive inductively at a new and relevant understanding of the statement of the problem. Referring to Bryman (Alan Bryman and Emma Bell, 2011), the mentioned points are typical for a qualitative research strategy.

The research process is similar to the classical qualitative research process presented by Bryman. First, an overview of academic and business research papers that considered the subject was conducted to develop an understanding of the broader problem area and derive the motivation and the statement of the problem for this study. Afterwards, to acquire sufficient understanding of the literature and theory within the academic field, an exhaustive and multidisciplinary literature review was completed. Theoretical understanding of the field and the subject formed the basis of the data collection, which was executed through semi-structured interviews with practitioners from the industry. Eventually, the research questions are answered through a combination of information gathered via the literature review and the research interviews.

2.2 Literature review

The literature review is done as a narrative. In reference to Bryman, this approach is broader in range, less focused and less strict about what is excluded from it than a systematic approach (Alan Bryman and Emma Bell, 2011). I chose this approach because I needed to get a broad and deep understanding of the topics related to ESI and knowledge management. In particular, topics like buyer-supplier relationships and cooperation need to be reviewed via a

broad approach due to their multidisciplinary. The goal of the literature review was to develop a broad understanding of the subject as a basis for the research interviews. Therefore, an understanding of the interaction of adjacent and underlying research fields to ESI and knowledge management in general and specifically to the petroleum industry had to be developed. I screened the databases with different buzzwords and found relevant and seminal research papers in every relevant field. To further deepen my understanding in the specific fields, I used these papers as a basis for evaluating their references for my research.

In completing the literature review, I encountered several difficulties that are dependent on the research issue. While relevant literature on the Norwegian petroleum industry and its historical operator-supplier collaboration or the buy-or-make decision was found easily, it was more difficult to identify relevant information into the multidisciplinary research issues. Literature and concepts on collaboration in general and buyer-supplier-relationship in particular have been researched in different academic disciplines and taken in different directions. Therefore, I evaluated literature on its applicability to the statement of the problem before including it in the literature review. Supplier integration and the concept of ESI as part of the collaborative approach of doing business are within the scope of current research. As this is a rather particular field of research, the academic arena is rather small and the basic conclusions were developed over the last several years. Despite the main points of the concept, the academics have not converged on a dominant paradigm concerning the outcome of involving suppliers early. Even though the literature review suggests an emphasis on the positive effects of collaboration in general and ESI in particular, much research needs to be done to exactly measure the effects. To evaluate the importance of several research works that investigate the outcome of early supplier involvement in different industries, I used two approaches. Firstly, I considered the number of citations in the work, and secondly, I consulted research papers that analysed research on the outcome of early supplier involvement. Neither the first approach on its own nor the second on its own is appropriate because of the risk of over- or underestimating the literature on it. But combined, the methods provide a reliable way to choose literature in this field.

Overall, it is arguable that this approach sufficiently covers the most relevant and applicable research. The outcome, the studies that I consider most relevant and relevant to the research problem, is presented in the literature review chapter.

2.3 Research interviews

To examine the status quo among practitioners regarding ESI and the utilization of suppliers' knowledge in the Norwegian petroleum industry, I decided to conduct semi-structured interviews. In such interviews, a guide to relevant issues is used to help to structure the interview, but at the same time, the interviewee is encouraged to talk freely about related issues. According to Bryman (Alan Bryman and Emma Bell, 2011), the method of semi-structured interviews had many advantages that are suitable for my research. Firstly, the method enhances the output of an interview, especially if the chance of interviewing the same person again is small. Secondly, the method enhances flexibility within the interview, enables greater insights into the interrelationships between variables and issues and provides further information into the research subject while at the same time the interview guide ensures the comparability of the outcome. On the downside, the outcome of the method depends greatly on the researcher's interviewing skills. Also, the method produces a large amount of data very quickly. My reason for choosing semi-structured interviews was that I wanted to understand the perspective of the participants on different subjects. Also, I did not want to exclude possibly important topics or insights by design or because of my unfamiliarity with the industry. Considering the limited time and resources available, the semi-structured approach seemed the most effective way of researching the research statement.

The interviewees were selected by a combination of purposive sampling and snowball sampling. According to Bryman (Alan Bryman and Emma Bell, 2011), the aim of purposive sampling is to strategically select interviewees who likely can contribute to a subject, while snowball sampling uses a participant's contacts to identify further possible participants. To gather the most relevant and contributing data, I selected on a hierarchy level project managers and contract managers with professional experience in recently completed field development projects as my primary target. On a company level, I selected major oil operators that have developed fields in the Norwegian continental shelf. In addition, I selected suppliers with capabilities in drilling and wells, the subsea and the geo and seismic fields as target companies for my research. I selected these technologic areas because the knowledge and know-how of these suppliers seemed to be the most complex in development projects, and therefore their early involvement seemed more likely to me. It is arguable that my selection of participants can result in relevant data on the one hand, but on the other hand, it is challenging to access.

Accessing the selected interviewees was very difficult. The first difficulty is the relatively small pool of possible participants, which was a result of the selection criteria. The second difficulty was the complicated process for participants and the involvement of gatekeepers when I attempted to access the selected people. Specifically, many companies only provide general switchboard telephone numbers for contact. The usual process to contact the selected companies therefore is to call the switchboard or to send a general email request for participation in the research. Afterwards, a second gatekeeper is involved, usually an employee from the HR department or the press and inquiry department. This gatekeeper looks for a suitable person to answer the research inquiry and forwards it to that person. This process of finding and accessing the right person is very time-consuming. The third difficulty is the unfortunate timing of my research activities, which conflicted with the main Norwegian holidays. By the time I had developed this work to a point at which I wanted to start the research interviews, many participants were preparing to go on vacation or had already left work for their holidays. Even though most of the difficulties were overcome eventually, they resulted in having to conduct many research interviews within the last six weeks of the time allotted to work on my thesis. Unfortunately, one of the largest Norwegian oil operators was not available for research interviews, and another smaller but innovative oil operator was not accessible due to current merger activities.

Overall, 18 companies were contacted, six companies participated to the research and eight research interviews have been conducted. Two oil operating companies and four suppliers have participated. The participants insisted that any specific feedback, any comment, any data and their insights be combined in an anonymous data set so they are not directly attributable to the persons or company involved.

All interviewees were sent an interview guide before the interview took place. The interviews were conducted over the phone in English and were recorded. The decision to use the telephone instead of in-person interviews was made mainly because of time and resource limitations. Bryman and Bell (Alan Bryman and Emma Bell, 2011) also argue that the difference in outcome between in-person interviews and telephone interviews is small. After the interview, the recordings were transcribed. The recording of the interviews was necessary and very useful for focusing the discussion with the interviewee during the interview and evaluating the outcome in detail.

The raw data gathered through the research interviews were analysed through open coding and the grounded theory approach. According to Strauss and Corbin (1990) cited by Bryman (Alan Bryman and Emma Bell, 2011), the grounded theory approach generates concepts and theory through coding the raw data. I decided to use the grounded theory concept because it provides a suitable way to convert raw data through open coding into findings. Through analysis, these findings become concepts or issues relevant to the research questions of this study.

2.4 Evaluation of the research methods

Firstly, the research method conducted is evaluated by the quality criteria of Guba et al. Secondly, a general evaluation of the conducted research interviews is done. According to Guba et al. (1994), qualitative research needs to fulfill two primary criteria, trustworthiness and authenticity. In particular, the four criteria of trustworthiness are discussed to evaluate the research.

Credibility

The criterion of credibility is met in two ways: firstly, by a respondent's validation in situations of possible unclear wording during the interview and secondly, by recording and accurately transcribing the research interviews. Increasing the credibility by validating the transcription of the interviews by the participants was not possible because of their accessibility.

Transferability

The transferability of the findings of the interviews to other industries or even to a different geographic area of petroleum development projects is limited. But interviewees' experiences of working with multiple similar companies within the industry should provide good insight into the researched industry. To increase the transferability of the study, I provided rich details on the industry and on the petroleum development projects on which the research is conducted. These information should be used by other researcher "…as a database for making judgments about the possible transferability to other milieu" (Alan Bryman and Emma Bell, 2011:398).

Dependability

Although the recordings and transcripts from the research interviews are not part of the file because of the need for anonymity, the criteria of dependability is achieved through an auditing approach. To a degree, I reported to the supervisor of this study on the progress, findings and participants of the research.

Confirmability

The confirmability of the research is achieved through clearly separating the findings of the research interviews and the analysis. Even considering that real objectivity is difficult to retain in qualitative research, I tried to not let my personal values or theoretical prejudices affect the conduct of the research.

In general, the conducted research interviews provided a great insight into how practitioners in the Norwegian oil and gas industry approach collaborating with suppliers, specifically through the concept of ESI, in their field development projects. More interviews, especially from the operator's point of view, could have been useful to increase the quality of the data in regard of the trustworthiness criteria. The purposive approach of sampling led on the one hand to very rewarding interviewees, but it also limited gathering data to a very late point in the process. In hindsight, the interviews with the operator's project managers helped me understand the practitioners' perspective on the subject of the thesis and substantially complemented the academic theory.

3 Literature review

This study explores the main theoretical approaches and literature relevant to the research problem. Firstly, I analyse the buyer-supplier relationship in the Norwegian petroleum industry as background. I then evaluate the buy-or-make decision in the petroleum industry as the starting point of this work. To lay the ground for analysing the Early-Supplier-Involvement concept as part of a buyer-supplier collaboration, the underlying buyer-supplier-relationship and supplier integration are presented. Also the contributions and importance of knowledge in general and in particular in the form of suppliers' know-how are evaluated. This is followed by an analysis of the potential advantages and disadvantages of the concept of 'Early Supplier Involvement' concerning use and management of suppliers' knowledge.

3.1 Cooperation and buyer-supplier relationships in the Norwegian petroleum industry

3.1.1 Introduction

Norway does not appear to have possessed any oil and gas resources until 1969, when the Ekofisk field was discovered. Production from this field began in 1971. Presently, Norway is Europe's largest oil producer and the world's third-largest natural gas exporter according to the US Energy Information Administration[1]. Norway is also the largest holder of oil and natural gas reserves in Europe. Norway's oil and natural gas reserves are entirely located offshore in the North Sea, the Norwegian Sea and the Barents Sea. To ensure maximized profit from its resources, the Norwegian government participates in the exploitation of the oil and gas reserves as an operator as well as a holder of oilfield stakes. On the operator side, the main actor in production and development of oil and gas fields is the energy company Statoil, which controls 70% of Norway's oil and gas production and 67% of which is owned by the Norwegian government. The government owned company Petoro holds stakes in oilfields through the state's direct financial interest and acts as the provider of production licenses (U.S. Energy Information Administration, 2014).

Cooperation between operators and suppliers in the Norwegian petroleum industry and its inherent buyer-supplier relationship are the underlying relationships examined in this work and are fundamental for the analysis of the concept of ESI and the utilization of suppliers' knowledge in the industry. The study concentrates on cooperation between operators, the

[1] http://www.eia.gov/countries/analysisbriefs/Norway/norway.pdf

buyer and focal company of the industry's supply and value chain, and the supporting supplier companies in the field development projects. The study's definition of operators and suppliers is based on the work of Sasson and Blomgren, who define operators as companies that "have been granted operatorships of oil and gas fields" (Sasson and Blomgren, 2011: 15). Suppliers are defined as "firms that provide oil and gas-specific services (drilling and well intervention, etc.) and/or generic services modified for use in the oil and gas industry (offshore supply vessels, etc.)" (Sasson and Blomgren, 2011: 15).

The value and supply chain whereby operators and suppliers interact in development projects refers to Figure 1 (provided by Intsok[2]).

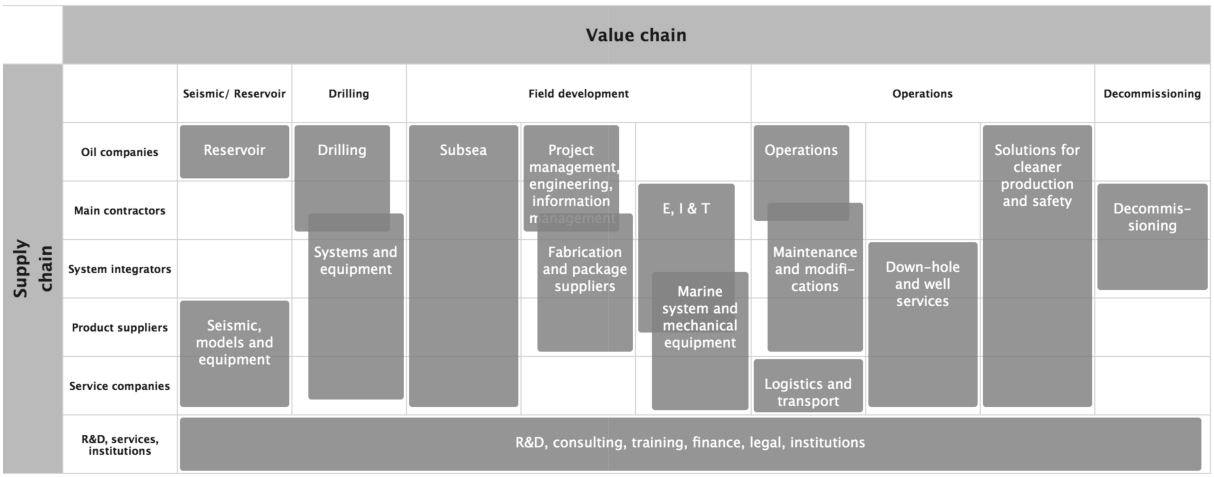

Figure 1: Intsok: A Gateway to the Norwegian Oil and Gas Industry

This figure shows the value chain of field exploitation in Norway with its attached supply chain, which provides the value chain's services. This is the main interaction field of the companies' cooperation and the buyer-supplier relationship in the industry. In this supply chain, the focal company, the operator, is the oil company. Supplying companies are all the other companies providing services to the value chain.

The Buyer-supplier relationship, respectively the operator-supplier relationship, has always played a major role in the oil and gas industry, especially in Norway for two main reasons: the need for effective supply-chain management and the need for innovation and knowledge development. Firstly, the output of the exploration and production sectors of the oil industry is the same for all competing firms: oil and gas with very narrow product differentiation. Therefore, operators can only differentiate themselves through their ability to find and

[2]http://www.intsok.com/Partners

produce oil and gas more efficiently. To achieve the high level of economic efficiency required, efficient and effective supply-chain coordination with a good buyer-supplier relationship can be the differentiating factor (Chima, 2011). Secondly, the discovery of oil in Norway initiated a need to develop oil- and gas-specific knowledge. This knowledge was gained through innovation and collaboration between the operators and suppliers over the past decades. Joint development of Norwegian oil and gas companies led to a strong buyer-supplier relationship within the petroleum value chain and is still a major cohesion to the operator-supplier relationship. In this innovation-orientated relationship, operators identify possible developments and associated problems and then request innovative solutions from their suppliers (Isaksen, 2003).

In the beginning of the Norwegian oil and gas era, field development and production was mainly done by large international oil companies because domestic companies lacked specific oil and gas knowledge. The Norwegian government reacted by establishing different policies, at first to attract foreign companies with foreign knowledge, later to build up oil and gas company clusters in Norway to strengthen national oil and gas specific competence, and most recently to support internationalization of Norwegian oil and gas companies. In the early years, suppliers' contributions to the project planning process were rather small. Over the years, the suppliers developed into highly experienced and international players while at the same time, the challenges in new petroleum field developments grew. (Sasson and Blomgren, 2011)

3.1.2 Cooperation forms in the petroleum industry

According to Olsen et al. (2005), at the beginning of the petroleum era in Norway, Norwegian operators entered into individual contracts with their suppliers, similar to traditional procurement. These individual contracts specified the objective of delivery by the supplier. This kind of contract demands an exact definition of the objective the supplier has to deliver. Exactly defining these objectives is very difficult in complex and often unique projects like petroleum development projects, especially when new technology or innovation is needed. The reasons for this behavior were on the one hand to transfer foreign petroleum-specific knowledge to Norway and on the other hand to fully control all aspects of risky development projects, particularly financial issues. On the downside, problems regarding the profitability of production arise because of high transaction and governance costs attributable to complex procurement. As a result, the focus of the relationship changed in the mid-1980s to the mid-

1990s. The need to produce oil profitably to respond to the low oil prices of the late 1980s led to new collaborative forms and supplier contracting. EPCI (Engineering, Procurement, Construction and Installation) contracts and project alliances were introduced. These three forms are currently the most used collaborative contracts in the petroleum industry.

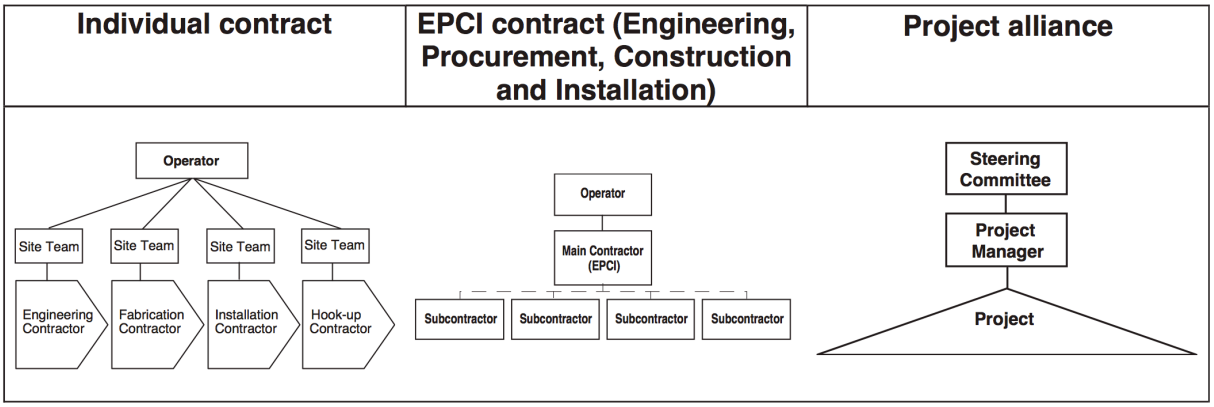

Figure 2: Forms of Contracts for Collaboration in the Oil and Gas Industry (Olsen et al., 2005:3)

In the individual contract setting, the operator is responsible for overall planning, integrating and monitoring of the project. Each supplier delivers his or her defined scope of work as agreed to in the contract, and the operator controls the work. For each phase, a different contractor with a different project organization is required. In the EPCI contract setting, the operator contracts with a main supplier who becomes responsible for delivering the entire project. The main supplier is therefore responsible for hiring sub-suppliers and coordinating and monitoring the project. In the project alliance setting of collaboration, the operator enters a contractual relationship with different companies, suppliers or other oil operators as equal partners. The partners establish an integrated organizational unit and share their resources, skills and competencies as well as the risks and rewards. The partners therefore become integrated through the whole project planning and execution process.

Even though all three forms can be used and combined to organize the many different kinds of suppliers needed to execute complex petroleum field development projects, the project alliance form represents collaboration that is regarded as most appropriate for ESI.

3.1.3 Development projects in the petroleum industry

The petroleum industry's value chain consists of upstream and downstream activities. Upstream activities are exploration and production of an oil or gas field, whereas downstream activities are refining, marketing and sales to the consumer. Development projects are situated in the upstream part of the value chain. In the petroleum industry, development projects involve a field from the discovery of oil until the start of regular production. Development

projects are large managerial challenges and highly complex due to the considerable sums of money they entail and the negative consequences of failure. To carry out development projects properly and avoid cost overruns or delays, many companies have developed their own project management models. This study relies on the project methodology developed by Statoil and described by Gudmestad in the book 'Petroleum Resources with the Emphasis on Offshore Fields'(Gudmestad et al., 2010).

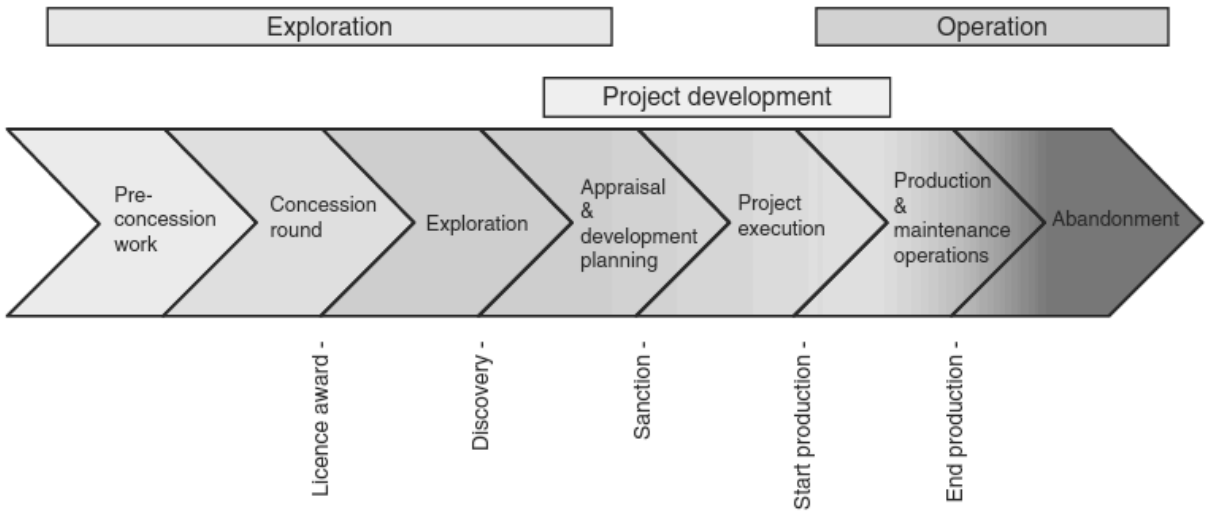

Figure 3: Stages of an Exploration and Production Venture, published in 'Petroleum Resources with Emphasis on Offshore Fields' (Gudmestad et al., 2010: 143)

The lifecycle of a petroleum field project consists of seven steps. For this study, the three project stages, 'project development', are relevant. While in the first two stages the operator has to bid for an exploitation license, in the following stages, the whole supply chain is involved. Suppliers regularly become involved in the project in the project execution phase. For this study, it is interesting to speculate whether involving suppliers earlier, perhaps in the appraisal and development planning stage, would improve the utilization of suppliers' knowledge and lead to a more effective or efficient outcome.

3.2 The Make or Buy Decision

As stated earlier, petroleum field development projects face challenges that can be characterised as increased technical and operational difficulties with related rising costs and risks due to the need to drill deeper and further offshore to find new oil and gas resources. In response to these challenges, the operator's strategy on the configuration of their supply-chain has become central. Because this is such an important question, the buy-or-make decision has become a question of supply-chain-strategy. To understand this topic, it is important to explore the relevant literature about why companies behave strategically the way they do.

Porter's (Porter, 1998) theory about the generic strategy model and its cost or differentiation focus is the starting point of every discussion on a company's strategy. The literature on transaction cost economies (TCE) provides an argument for a cost-focused strategy, while the resource-based view (RBV) makes an argument for a differentiation strategy. These two strategic perspectives underpin the buy-or-make strategy of a company. Das and Teng (2000) discussed the strategic viewpoints of TCE and RBV in the context of building alliances. They found that TCE companies see their competition based on competing over prices in the marketplace and their competitive advantage in producing goods and services at lower costs. Such companies try to build alliances to achieve their competitive advantage. In contrast, RBV companies see their competitive advantage in their competencies and knowledge and therefore try to build alliances to protect and strengthen their competitive advantage. Cousins (2005) assumed that it is necessary to develop a company's supply-chain strategy and the inherent buy-or-make decision based on both strategic approaches.

For the buy-or-make decision in the petroleum industry, these theories lead to the following evaluation. As the different parts of the value chain in the petroleum industry build upon each other, the make-or-buy strategy is related to the question of vertical integration or outsourcing. Vertical integration means incorporating companies along the supply chain, which finally leads to fully integrated petroleum companies that own all functions of the value chain and consequently produce their own product-service bundles. Chima (2011) discussed this topic in the paper 'Supply-Chain Management Issues in the Oil and Gas Industry". Chima points out that there are several advantages and disadvantages for both vertical integration and outsourcing.

Vertical integration gives a company greater control over the product quality, a greater coordination of operations along the value chain, acquisition of new technologies and potentially higher total profit margins. On the downside, vertical integration increases financial risks associated with economic downturns, causes a loss of expertise through the consolidation of management and operations of the companies, and increases the risk of missing external market opportunities because of the internal market and a loss of competitiveness because of the security of internal markets. Outsourcing as the buy part, on the other hand, allows a company to concentrate on its core competencies and enables the possibility of adding different kinds of capacities to flexibly compile various product-service bundles without adding overhead and fixed costs. Also, outsourcing helps a company grow

flexible without the need of monetary investments or risks and therefore guards the company against economic downturns. Further on, Chima concludes that anything that can be done more effectively by a supplier should be outsourced, or, respectively, bought. In addition, Chima points out that to manage the supply-chain effectively in a buy-orientated setting, the relationship management with the suppliers of the focal company is the key.

Quinn and Hilmer (1994) confirm these advantages and disadvantages of outsourcing respectively buying in the petroleum industry. They argue that it has become very difficult or even impossible to perform all the services and goods in-house as efficiently and on the technological cutting edge as is needed to gain a permanent competitive advantage. Furthermore, they argue that the main challenge of outsourcing is avoiding or minimizing its downside: loss of critical skills, cross-functional skills and control over a supplier. Loss of critical skills means the risk of becoming dependent to a supplier increases because of a loss of a performance-determining skill. Loss of cross-functional skills means the risk of losing the positive developments and solutions that arise from cross-departmental collaboration in the company. Loss of control over a supplier means the risk incurred when suppliers' and buyer's priorities stop matching, e.g., if the supplier tries to bypass the buyer in the marketplace. To avoid these risks, Quinn and Hilmer conclude that the buyer has to carefully develop its core competencies, assess potentially strategic suppliers and establish good relationships with them. Spekman (1988:78) even argues that the buying company can achieve the "advantages of vertical integration without the cost of ownership" if the collaboration and the relationship to its suppliers are developed properly.

In addition to these theories, Hoetker (2005) researched the buy-or-make decision in the face of uncertainty about technology in the notebook industry. Specifically, Hoetker researched the circumstances under which a buyer prefers to outsource activities to an external supplier rather than to an internal supplier. He reports two interesting findings. Firstly, when technological uncertainty is low, the decision is made on the basis of differences in technical capabilities. With increasing technological uncertainty, the buyer focuses more on suppliers it has cooperated with in the past and has a high-involvement relationship with as an alternative to internal suppliers. Furthermore, empirical studies have examined the role of relationship on the outcome of an outsourcing strategy. Handley and Benton stated that the buying firm "must focus on the provider if they are to fully realize their performance expectations" (Handley and Benton, 2009:37). In addition Carr and Pearson (1999) found that strategically managed long-

term relationships between the buyer and the supplier have a positive financial impact on the buyer's company.

For this study, the buy-or-make decision is the starting point of the analysis of buyer-supplier collaboration and early involvement of suppliers. The relevant assumption of the buy-or-make decision for the statement of the problem is that outsourcing is crucial, especially in large and complex projects like field development projects in the petroleum industry (Martinsuo and Ahola, 2010). Outsourcing is necessary to successfully execute tasks, overcome the challenges associated with these projects, and maintain a competitive edge, because "suppliers as external sources of knowledge and innovation have an important role in any industry" (Ruuska et al., 2013: 543). To profit most from outsourcing, it is necessary to avoid the disadvantages previously described and to enable the advantages. This can be done through establishing collaboration instead of cooperation between the buying and supplying companies. The terms 'cooperation' and 'collaboration' have different meanings. In the literature, cooperation is defined as any interaction between two companies based on business agreements and contracts, including those with a power advantage, for example, for the buying company. Collaboration, on the other hand, is defined as activities based on partnership, commitment and balanced power (Chima, 2011; Quinn and Hilmer, 1994; Spekman, 1988).

3.3 Buyer-supplier collaboration from a relationship viewpoint

ESI as a concept is a form of vertical collaboration. As defined in the previous chapter, collaboration and cooperation are distinguished by their buyer-supplier relationship. To examine the relevance of the buyer-supplier relationship on collaboration in general and the problem area in particular, different aspects of the buyer-supplier relationship are presented and evaluated. Firstly, the overall outcome of suppliers' contributions to buyer-supplier relationships is summarized, followed by an evaluation of different kinds of relationship. Finally, different kinds of collaboration in projects are presented.

3.3.1 Supplier contributions to buyer's company

Gadde and Snehota (Gadde and Snehota, 2000; Gadde, 2010) researched the buyer-supplier relationship in depth. Their theories link suppliers' contributions with the buyer-supplier relationship and its costs.

Suppliers contribute to buyers' success in two ways: economically in terms of cost reductions and substantially in terms of development and innovation. While traditional purchasing theory claims that the main concern of buyer-supplier relationship is to find the lowest price for every single transaction, a total cost perspective provides insight into the economic benefits evolving from the buyer-supplier relationship. Gadde and Snehota provide the total cost perspective on relationship costs and benefits (Gadde and Snehota, 2000:308).

Relationship Costs	Relationship Benefits
- Direct procurement costs - Direct transaction costs - Relationship handling costs - Supply handling costs	- Cost benefits - Revenue benefits

The main point is that there are many more influences on efficient purchasing than are considered from the traditional purchasing perspective. Besides the direct procurement costs incurred in traditional procurement, other costs and potential benefits related to purchased items should be considered in procurement decisions. Therefore, it is important to purchase the good with the best total cost rather than the best direct cost.

Direct procurement costs can be directly measured and represent the costs related to the purchase as reflected in the invoice of the supplier. Transaction costs are harder to measure. They represent costs related to the transaction: handling costs, transportation, ordering, etc. Relationship handling costs are very difficult, and sometimes impossible, to measure. They include the costs to foster the relationship with a supplier and to interact with him or her. Supply handling costs represent structural costs common to the handling of the whole supplier base and therefore are not directly relatable to a transaction or to a single supplier relationship. Such costs include administrative systems and communication.

Relationship benefits are more difficult to measure because they are often hard to even identify. Cost benefits represent savings for the buying company based on the relationship to the supplier, for example, because of improved operational efficiency, joint development or integrated logistics. Revenue benefits describe the impact of the supplier relationship to the income of the buyer, for example, because of better sales due to the use of a specific supplier (co-branding). Supporting this, Ford claims that cost reducing benefits based on

rationalization in operations, logistics, etc., are "built on a reduction of the number of suppliers and close long-term relationships with those remaining" (Ford, 2011:76).

In addition to economic contributions, Ford (2011) also claims that suppliers make substantial contributions to buyer-supplier relationships, mainly in development and innovation matters. Suppliers are sources of technological innovations and developments that help buyers maintain their competitive edge because most buying companies offer services based on a combination of technology, not on the technology itself. Furthermore, suppliers contribute as problem-solvers. Their problem-solving ability often evolves in development processes for new products as the buying company invents a product-idea and then demands technical solutions. It is important to involve suppliers as early as possible in the development process because up to "80% of the total costs of a new product are determined in the design phase" (Ford, 2011:77).

In terms of the statement of the problem, the main concern about a supplier's contribution to a buyer's success is the possibility of economical and substantial benefit that can only be implemented through buyer-supplier relationship and collaboration. It is also important to weigh the potential benefits of a buyer-supplier relationship against the costs of fostering these relationships.

3.3.2 Variations among relationships in regularity and involvement

A buyer's supply-chain network usually incorporates different kinds of relationships. Gadde and Snehota (2000) developed a matrix of four different concepts of relationships that are distinguished by frequent and rare regularity and low and high involvement.

Low-involvement relationships are widely denoted as 'arm's-length relationships' (Crémer, 1995; Gadde, 2010; Hoyt and Huq, 2000). The central aim of arm's-length relationships is to not become dependent to a supplier and to lower direct procurement costs. The relationship to these suppliers can be characterized by limited coordination, adaptions and interaction. From the buyer's viewpoint, there are three advantages to this approach (Gadde, 2010):

1. reduced transaction uncertainty: By relying on one supplier, the risk of not receiving the agreed-upon good is higher than if the buyer has a number of alternative sources;
2. enhanced technological flexibility: Single sourcing can lead to a technological lock-in, while multiple sourcing maintains technological flexibility in the long term; and

3. opportunities for price pressure: Multiple sourcing encourages competition between suppliers and gives buyers the opportunity to play suppliers against one another to get the best possible price.

Gadde summarized the economic downside of low involvement relationships as higher direct procurement costs due to splitting orders among suppliers, high hidden costs due to adapting standard goods to fit to the needs of the buyer and high supply handling costs due to the use of different suppliers to avoid delivery problems. From a relationship point of view, the major downside of the low-involvement approach is the minimal opportunity to benefit from possible cost and revenue benefits.

Gadde (2010) views high involvement relationships as the direct opposite of low involvement relationships. Increasing involvement leads to an increasing level of interdependence between buyer and supplier. The benefits of increased involvement are potentially lower production costs, improved service levels and production flexibility due to better coordination, adaption and interaction. Higher levels of involvement lead in particular to access to suppliers' skills, knowledge and capabilities, which can result in better products and services. The downside of a high level of involvement is that it increases relationship-handling costs. Therefore, the possibility of producing non-standardized products and the operational benefits described above must economically outweigh the required effort and costs.

Because the benefits of high involvement relationships are most likely not available on the first day of interaction, the decision about the level of involvement is a strategic investment decision because relationship handling costs increase from day one. Therefore, high involvement relationships seem to be more long term because of the investment decision underlying the relationship. The development of high involvement needs business adaptions on both the buyers' and the suppliers' side. Once these adaptions are made, both parties tend to maintain the relationship to reap the potential benefits. Longevity also increases because the parties need to get to know each other and build trust to foster the relationship. Therefore, most high-involvement relationships are also regular. Low-involvement relationships can be short- or long-term and regular or irregular, but the low-involvement high-frequency combination tends to occur most often. (Gadde, 2010)

Gadde and Snehota (2000) also developed a matrix of combinations based on the features involvement and regularity.

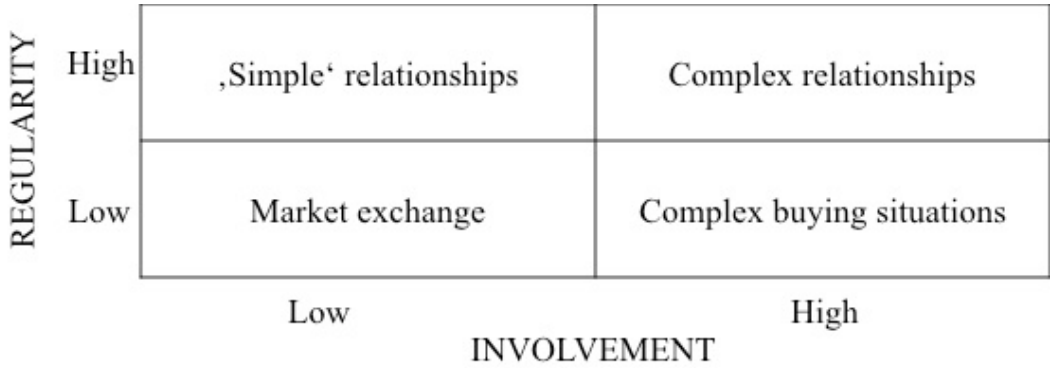

Figure 4: Involvement and Regularity in Relationships (Gadde and Snehota, 2000)

'Simple' relationships therefore represent the arm's-length and high-regularity relationship. This relationship establishes routines through its regularity and the buyer's freedom to change suppliers easily. Through the combination of low regularity and low involvement, market exchange relationships offer the possibility of cost and efficiency increases due to price pressures. Complex relationships, on the other hand, enable efficiency improvements through mutual adaptions in business and therefore cost and revenue benefits over time. Complex buying situations are high-involvement relationships because of the complexity of equipment and systems needed at irregular situations.

3.3.3 Different alliance relationships for project design and execution

Hobbs and Andersen (2001) developed a model of four different configurations of alliances in the project-planning or front-end phase and the execution phase of projects. The term 'alliance' is used in their model much as 'collaboration' is used in this study. The model is based on an extensive study of large and complex engineering projects to identify best practices in project management. The dimensions of the model are distinguished in matters of relationship.

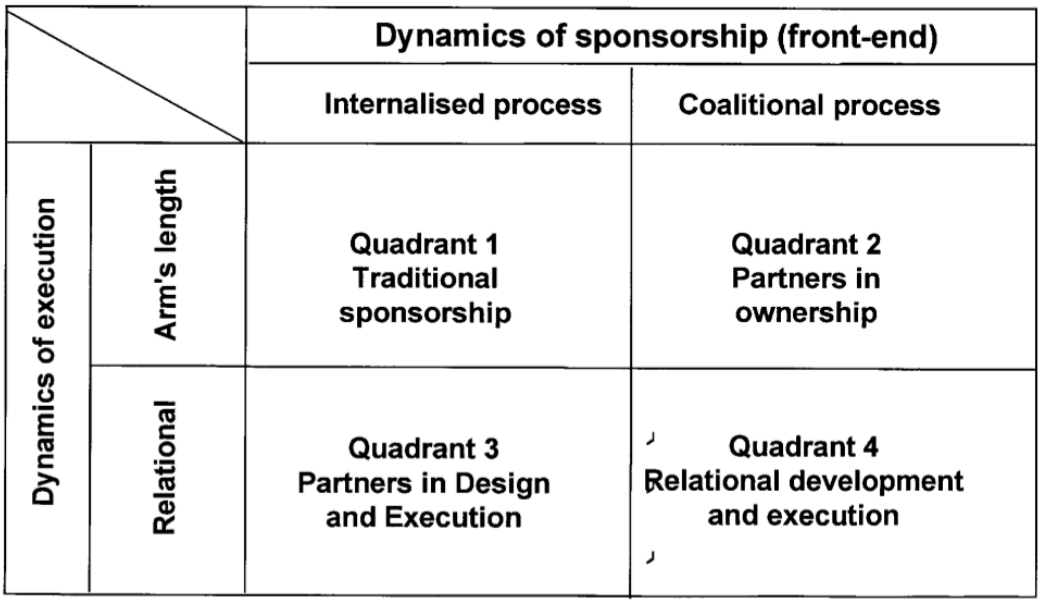

Figure 5: Four Configurations of Project Development and Execution by Hobbs and Andersen (2001:466)

Quadrant one and two are low-involvement relationships based on competitive bidding and tendering of contracts. Quadrant one represents the classic outsourcing setup of a project. The buying company designs and fully specifies the project's objective, plans the execution and allocates execution to several suppliers for competitive bids. The suppliers' influence on the object's design is limited, while the management effort for the buying company is high. The second quadrant represents a different low-involvement configuration. The bidding process takes place early in the design process, and the buyer requires a complete design and engineering of the object and a thorough description of how the project will be executed. The supplier or a conglomerate of suppliers competes with their designs and execution plans; thus, they have extensive influence on the design, while the buyer controls the supplier through requirement guarantees and due diligence. The management effort required of the buying company is lower and the project risk is largely shifted to the supplier.

Quadrant three and four represent the findings of high-involvement configurations in project development and execution. The main difference between the two configurations is the level of equality among the companies involved in the relationship. Quadrant three represents project configurations in which the focal company designs and plans the project in-house. Project execution has elements of collaboration, but the buyer remains in a dominant position. The relationship approach is applied through the buyer's experiments to overcome the limits of arm's-length contracting.

Hobbs and Andersen (2001) described four different approaches to this kind of alliance.

- Partnering: A buying company designs and plans the project, a supplier wins the job via competitive bidding, and partnering means that the owner's project management team starts team building and exchanges activities to improve communication during execution, especially in case of problems and change requests.
- Frame agreement: A buying company designs and plans the project and lets suppliers that are contracted on a frame agreement via competitive bidding for a range of goods and services to be provided over several projects complete parts of the job. Through the collaboration in multiple projects, the buyer's dependency increases, but on the upside, frame agreements lead to operational efficiency and avoid costs and delays attributable to unnecessary competitive bidding. Frame agreements can also lead to long-term relationships and familiarity and thus enable the possibility of early supplier involvement in the front-end phase of projects.
- One-off integrated project teams: Such teams are used by the buying company when it researches a specific project but cannot develop a feasible concept for execution. The buying company therefore assembles a concept team of specialized suppliers and engages them to develop a feasible solution. The cross-functional and cross-company teams are in many cases successful and retained through project execution.
- Sticky informal networks: Such networks are cultural phenomena originating in French and Japanese buyer-supplier relationships. Sticky informal networks are arrangements between buyers and suppliers with informal exchanges and expectations based on the relationship between the companies and the expectation that a dominant buyer will treat its suppliers justly and compensate them fairly. This means that the buying firm expects the supplier to contribute in the relationship and to project execution, as do suppliers in frame contracts or integrated project teams.

Quadrant four represents collaborations in which the allying companies are equal in terms of power and dominance in the project. This configuration is characterized by heavy involvement in the project development, design and execution phases by a group of companies forming temporary joint ventures. The role model is a coalition of companies forming a joint venture to develop and execute a project under a government concession. In this configuration, there is no difference between the company that designs or assesses a design of a project and the one that executes it. This kind of alliance leads empirically to significant improvement in efficiencies of design, building and operating. Participating

companies can win or lose in this collaboration due their lucrative potential and correspondingly high risk.

For this study, alliances characterized as ‘partners in design and execution’ (quadrant three) and ‘relational development and execution’ (quadrant four) suit the concept of ESI best in terms of buyer-supplier relationships.

3.4 Importance and use of knowledge in cooperation

To evaluate the statement of the problem, it is necessary to evaluate the importance and utilization of knowledge in collaboration. Therefore, this chapter examines suppliers’ knowledge as an asset, the strategic relevance of knowledge in general and theories about cooperation in knowledge management.

3.4.1 Concept of knowledge and know-how

To discuss the value and use of suppliers’ knowledge in buyers’ projects as an asset in collaboration, knowledge as an asset must be characterized. This study uses the concept of knowledge and know-how as a marketable asset as presented by Teece (1998), who identifies five dimensions of definition on knowledge in a business setting.

- Codified/Tacit knowledge: Codification of knowledge and its cost of transfer are related. The higher the level of codification, the more easily and economically transferable knowledge is. Tacit knowledge requires face-to-face contact to be transferred.
- Observable/Non-observable knowledge in use: Observable knowledge can be transferred by observing knowledge in use, for example, through reverse engineering of products. Non-observable knowledge such as processes are more protected from unintended transfer.
- Positive/Negative knowledge: Knowledge of discoveries of positive technological approaches and failure.
- Autonomous/Systematic knowledge: Autonomous knowledge needs no modification of the system in which it is embedded, while it improves the system’s power; systematic knowledge needs modification or re-design of the system it is embedded in.
- Protection of intellectual property: The degree and type of protection the knowledge is secured from imitation through patents, trade secrets or trademarks.

These dimensions enable the characterization of knowledge as a marketable asset respectively a company's competitive advantage. Therefore, Teece argues that a company's knowledge, in this case suppliers' knowledge, is a marketable asset or a source of competitive advantage if that knowledge becomes know-how. Know-how is characterized as knowledge of how to accomplish something. This can be based on a specific codified knowledge extended by knowledge of usage or its adaptability, which means a company's ability to transfer and use its knowledge in different contexts. Know-how is tacit knowledge because the company's know-how is secured from imitation by evolution or protection laws. Imitation in this context is the reproduction of know-how by a competitor. Suppliers use and develop this kind of know-how in their specific knowledge domain at an expert level and gain competitive advantage through it. Buyers, on the other hand, use less specific knowledge in a broader domain and develop know-how in integration and use of external know-how (Teece, 1998).

To attain a competitive advantage and offer attractive collaborations for the buyer, the supplier has to generate two kinds of know-how: know-how in terms of technology, operation and innovation in the supplier's particular field and know-how in terms of integration, adaptability and interaction. The combination of these two domains determines in general the suppliers' ability to effectively and efficiently participate in collaboration (Croom, 2001). As a consequence, the incentive for a buying company to collaborate with its supplier so as to access the supplier's know-how is high, if that supplier's know-how is strongly adaptable, non-imitable and crucial for the buying company. Interestingly, LaBahn and Krapfel pointed out that customer's knowledge and technological capability amplifies suppliers' willingness to participate in ESI (LaBahn and Krapfel, 2000).

3.4.2 Strategic perspective on knowledge

The perspective on the importance of knowledge has changed over the last decades. At first, knowledge was seen as the engine of production, growth and progress. Later, it was seen as a critical source of competitive advantage and the input and primary source of value for a firm through the 'resource-based' view (RBV) (Mowery et al., 1996). The RBV developed into the 'knowledge-based'-view (KBV), which considers a firm's specific knowledge to be the determining factor of that company's competitive advantage. (Grant, 1996)

Grant and Baden-Fuller (2004) further discussed basic premises about the use of knowledge as a production factor. Firstly, knowledge is an important productive resource in terms of

value and a main source of Ricardian rents. Secondly, the transferability of knowledge is limited. Thirdly, knowledge is subject to economies of scale and scope, both terms of replicating or discovery costs and if the knowledge is not specifically associated with one product. Different types of knowledge vary in the extent of the economies of scale and scope. Fourthly, knowledge presents difficulties for economic organization through the assumption that efficient knowledge generation is done by individual human beings through specialization, but it simultaneously produce a marketable entity that typically requires the application of different types of knowledge. Therefore, the company has to find a way to manage knowledge under these assumptions.

3.4.3 Knowledge Management

The approach on knowledge management in collaboration that is relevant for this study is based on two theories, the concept of 'core competencies' (Prahalad and Hamel, 1990) and the 'dynamic capabilities' theory. (Teece et al., 1997) The core competencies approach states that to gain a competitive advantage, the company has to develop core competences that provide access to a wide variety of markets, make a significant contribution to the customer's benefit from the end product, and are difficult to imitate. Knowledge is understood as the asset underlying core competences. Prahalad and Hamel described the concept as collective learning across the corporation, which is understood as collective tacit and explicit knowledge of a company to deliver a performance. The 'dynamic capabilities' theory focuses on the importance of developing a company's knowledge to keep up with the changing requirements of the company's environment. This can be done through internal reconfiguration of resources or through external combination of resources. Teece et al. identify dynamic capabilities as the "capacity to sense opportunities and to reconfigure knowledge assets, technology and capabilities to achieve sustainable competitive advantage" (Teece et al., 1997:73).

These two theories lay groundwork for the discussion of the two knowledge management approaches in inter-firm cooperation in terms of use of knowledge analysed by Grant and Baden-Fuller (2004). The first approach is described as 'exploration', or the organizational learning perspective, meaning to acquire foreign knowledge or increase the company's own knowledge through learning or acquiring it from the cooperating company. The cooperation and relationship with the other company are seen as a vehicle for absorbing knowledge. In this context, the problems of technology spillovers (Jaffe et al., 2000) and the indirect flow of knowledge (Appleyard, 1996) are relevant. Also, the companies may get into a competition

for learning in which each company tries to learn more and faster than the other company participating in the cooperation. This can make cooperation and a further relationship between these companies difficult.

The second approach to knowledge management is described as ‘exploitation’, or knowledge application. Cooperation is therefore seen as a mutual possibility for accessing the companies’ knowledge and capabilities. The motive for collaboration is no longer the transfer of knowledge, but rather access to knowledge to exploit complementarities without extending the base of knowledge (Håkansson and Waluszewski, 2014).

These two strategic approaches to knowledge management in cooperation are the most important for this study. Even though neither approach appears to be dominant (Mowery et al., 1996), this study supports Grant and Baden-Fuller’s contention (2004) that accessing knowledge offers a better upside for inter-firm collaboration and for research on early supplier involvement in particular.

3.5 Collaboration and (early) supplier involvement

Large, complex projects with high technological uncertainty such as field development projects in the petroleum industry are typically organized as temporary inter-firm projects within a supply network. Therefore, it is crucial for operators to cooperate with suppliers (Martinsuo and Ahola, 2010). This section of the dissertation analyses the coherence of buyer-supplier collaboration and early supplier involvement.

3.5.1 Collaboration and supplier integration

In addition to the previous distinction between collaboration and cooperation, collaboration is defined as the "process by which partners adopt a high level of purposeful cooperation to maintain a trading relationship over time" (Spekman, 1988:77). Furthermore, Spekman (1988) distinguishes collaboration from cooperation by its inter-company-relationship and characterizes collaboration by long-term cooperation, bilateralism, mutual commitment and balanced power between companies through interdependence. Cousins (2005) further identifies four different kinds of collaboration:

1. sharing of production plans and systems;
2. adaption of production processes;
3. common work for cost reduction; and
4. early supplier involvement.

Sharing product plans and systems is often described as operational collaboration with a cost focus, whereas the other three kinds of collaboration are strategic collaborations with a focus on developing competitive advantage by combining capabilities and competencies. A major benefit for the buying company in establishing a vertical collaboration with a high-involvement and long-term relationship is opportunity of aligning technological strategies in the long term, influencing the supplier's future technological research and development and securing the access to this knowledge.

According to the distinctions among types of collaboration, supplier integration means the suppliers become integrated in the information flow of the customer's project. This can occur through IT in shared production or demand plans or through integration of suppliers' employees in cross-company work groups or meetings (Ragatz et al., 2002). In complex projects, the specific outcome of a supplier's contribution is difficult to define up front, and therefore negotiations about the features, design and delivery of the solution need extend

beyond the initial contract. Also, some projects involve so many suppliers that integrating them requires establishing a separate project office (Martinsuo and Ahola, 2010). Supplier integration is regarded in this study as a way of managing or executing collaboration to achieve the best outcome. The main goal of supplier integration is to enhance the performance of a company's collaboration within a supply network by exploiting coordinative potentials of the attached value-creating activities (Tan, 2001). Following Martinsuo and Ahola (2010), supplier integration is defined as collaboration and control between the project lead and its suppliers during project planning and execution.

As discussed earlier, oil and gas companies started a supply-network strategy in the 1990s to focus on their core competencies. They uses collaborative approaches like 'alliances' and 'integrated project organizations' (Olsen et al., 2005) to access external resources. Supplier integration in this supply-network perspective (Hagberg-Andersson et al., 2000) can be understood as the process underlying planning and execution of projects within supply-chain networks. Supplier integration represents therefore a mediating behavior on activities undertaken within a buyer's supply-network.

Also it is necessary to observe that in some research, the term 'supplier integration' is used interchangeably with 'supplier involvement'. For example, Handfield et al. (1999) used the exact same definition for 'supplier integration' as others used for 'supplier involvement'. To minimize the risk to confusing the meaning of supplier integration with that of supplier involvement in the theory of early supplier involvement, only the term '(early) supplier involvement' will be used in this study.

3.5.2 Definition and concept of early supplier involvement

Early supplier involvement represents an strategic type of vertical buyer-supplier collaboration (Cousins, 2005) and is widely discussed by researchers in the context of new product development. 'Supplier involvement' and 'early supplier involvement' are often used simultaneously and with the same strategic meaning and are only distinguished by the timing of the involvement. Early supplier involvement is defined as a process in which suppliers provide information and directly participate in decision-making for purchased items in the buying company's new product/process/service development. This involvement can range from consultation for information to full responsibility for developing components or systems as part of the project and can occur in any point in the process. Early supplier involvement is

expected to enable improvement of quality, access and application of technology while also reducing costs and development time of the project (Mikkola and Skjøtt-Larsen, 2006; Ragatz et al., 1997; Wynstra et al., 2001). Petersen et al. define early supplier involvement as "an important coordinating mechanism for decisions that link product design, process design and supply chain design together" (Petersen et al., 2005:372).

By definition, early supplier involvement is distinguished from alternative forms of collaboration because it takes place before regular production or operation. Some scholars therefore use the terms 'supplier involvement' and 'early supplier involvement' interchangeably to describe collaboration before regular operations. Some researchers distinguish these terms based on the timing of suppliers' involvement within the development phase (Mikkola and Skjøtt-Larsen, 2006; Petersen et al., 2005). Petersen et. al. (2005) provide an overview (Figure 6) of possible supplier involvement points. Supplier involvement therefore represents in terms of time the collaboration in one phase of the project, whereas early supplier involvement takes place in the assessment, concept and design/engineering phase (Ragatz et al., 1997).

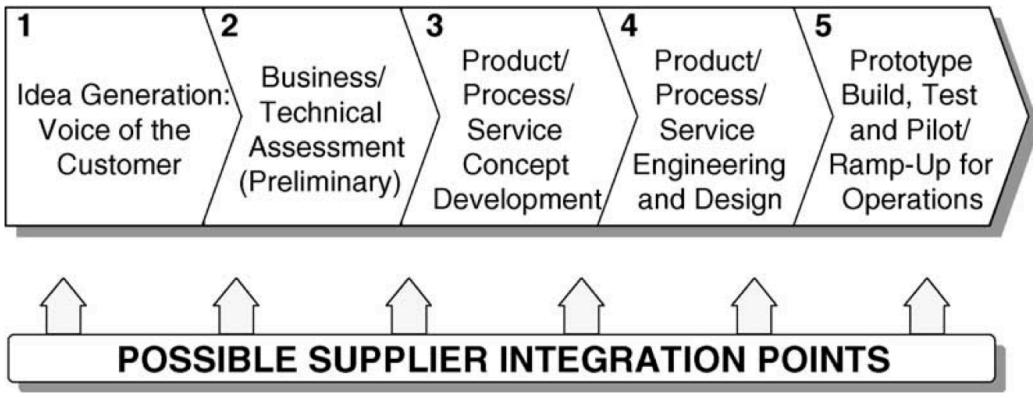

Figure 6: Possible Involvement Points by Petersen et al. (2005)

During Phase 1, the buyer assesses and selects projects and generates the overall idea for them. In Phase 2, the project is planned, the business case for the project is made, technical solutions are assessed and outsourcing and supplier involvement decisions are made. In phase 3, the detailed concept for the project and the collaboration in the supply chain is developed and the required technologies are selected. In Phase 4, detailed engineering and design are completed, and in Phase 5, the ramp-up for operations is done. Petersen et al. (2005) state that supplier involvement is possible in every phase of the project, while Mikkola and Skjøtt-Larsen think that involvement in the first and second phase is unlikely because companies seem to regard the actions taking place in these phases as their core competencies (Mikkola

and Skjøtt-Larsen, 2006). It seems therefore important for a company to decide very early in phase 2 what performance and technology will be provided in-house and which knowledge and technology supplier involvement is needed. Also, it seems clear that the timing of supplier involvement depends on the buyer's desired form of project setup based on the models by Hobbs and Andersen (2001) presented in chapter 3.3.3.

This study understands the aim of the early supplier involvement concept as buyer-supplier collaboration to examine feasibility of technological solutions and to discuss technological developments relevant for the buyer in the technical assessment in late phase 2, and the conceptual phase (3) and the design and engineering phase (4) of the project. ESI is therefore a concept for using the specific knowledge and know-how of the supplier to improve the technological solution of the project effectively and efficiently. This is supported by the findings of Ragatz et al. (2002) who report that "in cases when the supplier possess high levels of expertise in a technology that needed to be adapted to a particular product development initiative, companies were integrating suppliers very early in the development cycle to exploit all possible opportunities for value engineering and cost reductions. Suppliers in such cases work closely with buying company design engineers to solve problems related to manufacturability, integration of the technology, cost reduction and product performance" (Ragatz et al., 2002:398)/ By extension, the petroleum field development projects of the operators are seen as a new product/process/service that is developed through ESI.

3.5.3 Potential advantages and disadvantages of early supplier involvement

This chapter analyses potential advantages and benefits of ESI, described by different scholars and its disadvantages. Academics do not distinguish between the terms 'supplier involvement' and 'early supplier involvement' because the benefits are perceived to be similar. Even though the concept of ESI is mostly researched in new product development projects, the advantages and disadvantages are transferable to this study's research problem.

Potential Advantages

Wynstra et al. (2001) summarized the potential benefits of supplier involvement as the possibility of using the "extra and specialized development potential embedded in the skills, competencies and knowledge of suppliers", which "can make product development more efficient, by decreasing input (less development costs, less design changes, less engineering hours) and […] increasing the output (a better product, a more innovative product, a faster market introduction)". Similar assumptions about the benefits of supplier involvement are

found in almost every study about this topic. These benefits are a continuation of the relationship benefits potentially occurring during inter-firm collaboration presented in chapter 3.3.1. Van Echtelt and Wynstra analysed the potential benefits of early supplier involvement and separated them according to their impact on a buying company's strategic and operational advantages. Operational impact describes improvements in efficiency and effectiveness through suppliers' involvement in a specific project. Strategic impact describes long-term improvements that may not be directly traceable to a specific project but increase buyer's performance in terms of supplier involvement over time (van Echtelt and Wynstra, 2001).

Operational or short-term advantages can be divided into efficiency and effectiveness benefits. Supplier involvement can affect a buyer's specific project mainly by improved project cycle time, improved resource utilization and reduced development and transaction costs. This impact arises for different reasons: The supplier can identify potential problems up front, eases communication and information exchange and provide extra personnel to shorten the critical path (Bonaccorsi and Lipparini, 1994; Brown and Eisenhardt, 1995; Clark, 1989; Kamath and Liker, 1994; McGinnis and Vallopra, 1999; Ragatz et al., 2002, 1997). Ruuska et al. (2013) analysed suppliers' capabilities and contributions. Suppliers contribute with their operational capabilities, their know-how in technology and operating in their particular business and their innovativeness and development capabilities.

Even though suppliers' knowledge can improve efficiency in a particular area, for this study, improvement in effectiveness is more important. The impact on a buyer's performance in terms of effectiveness can be associated with a better solution both short and long term. Early supplier involvement improves a buyer's project effectiveness in many ways. The supplier can add information and expertise regarding new technologies, suggest better component alternatives or develop parts of the project to reduce internal complexity and manufacturing costs (Brown and Eisenhardt, 1995; Clark, 1989; Dowlatshahi, 1998; Ragatz et al., 2002, 1997).

Overall, the greatest benefit of involving suppliers early is suppliers' help in developing a better solution by providing access to his or her technological resources, capabilities and design ideas (Bonaccorsi and Lipparini, 1994; Clark, 1989; Handfield et al., 1999; Ragatz et al., 2002; Rosell and Lakemond, 2012). In addition, Wasti and Liker (1997) found evidence that involving top-tier suppliers early, as in the early conception and planning phases, can

help develop a feasible and better solution by combining companies' knowledge and capabilities in cases of high technological uncertainty.

Early supplier involvement in the conception and planning phases also benefits future buyer-supplier collaboration in developing projects. On the one hand, even if there is no direct improvement for a specific project the supplier was involved in, this project-collaboration can increase the buyer's capacity to involve suppliers in future project collaborations (Dyer and Singh, 1998). Also the buying company secures access to the suppliers' knowledge by establishing a high-involvement relationship with the supplier (Ragatz et al., 1997). A particular advantage of involving a specific supplier in different projects over time is that the companies can align their technological strategies and the buyer can influence the future technological development and investment of this supplier (van Echtelt and Wynstra, 2001).

Potential disadvantages

The major disadvantages and risks of ESI are based on the relational character of the collaboration. Bruce et. al. (1995) empirically researched the potential disadvantages and risks in collaborative development projects. They found that leakage of information, loss of control or ownership, longer time-to-operation time, conflicts due to differing aims and objectives, loss of partners' commitment and higher development costs are the main risks of collaborative development projects. Most such risks seem to be associated with the relationship and trust between the actors. For example, risks of longer time-to-operation and increasing development costs may be less likely when the participating companies have collaborated before and their operations are aligned.

While Bruce et al. described the main risks of collaboration in development projects; the risks of collaboration in an early supplier involvement approach seem to differ.

It is arguable that if the major benefits of ESI are based on the extensive use of suppliers' knowledge, sharing of information and joint technological development, the major disadvantages of ESI also arise from the use of knowledge. Mikkola and Skjoett-Larsen (2003) summarized the major disadvantages and risks of ESI as the possibility of losing proprietary knowledge, losing internal key-competencies and the opportunity for competitors to access or copy key technologies through utilizing the same supplier. They also see a risk of increased dependence on key suppliers for innovation and development and increased

standardization of components through specified interfaces. On the other hand, Petersen et al. (2005) identify being 'locked-in' to a particular technology or supplier as the main disadvantage. This can be especially problematic when the company has to decide which supplier to involve early under technological uncertainty about the future 'dominant' design. In general, to justify the early involvement of suppliers, the expected impact of joint development and knowledge generation must exceed the risks. High-involvement relationships, supplier assessment and a buyer's ability to involve suppliers early in an efficient and effective way seems to lower these risks.

Despite the potential benefits, the results of empirical research on the exploitation of these benefits are mixed. Rosell and Lakemond (2012) analysed different empirical studies on suppliers' contributions in joint knowledge generation in projects. They found several studies that supported theories about a positive impact on the outcome and others that denied innovative contributions based on suppliers' knowledge. It seems that although the advantages and benefits of early supplier involvement are obvious from a theoretical point of view, the empirical results do not always support them.

Therefore, it will be interesting to analyse the potential problems and success factors of ESI to eventually research the impact of suppliers' knowledge on projects of the petroleum industry. This is particularly interesting for this work because although large oil and gas contractors reportedly have been using collaborative approaches with key suppliers in the early project phases since the 1990s, the potential benefits have not been observed, as the study of the Norwegian Petroleum Directorate from 2013 states.[3]

3.5.4 Sources of problems for ESI

Early supplier involvement needs to overcome different problems to enable its potential benefits. Wynstra et al. (2001) analysed problems occurring in collaboration and identified three categories. Support for their analysis is found in the work of LaBahn and Krapfel and Ragatz et al. (LaBahn and Krapfel, 2000; Petersen et al., 2005; Ragatz et al., 2002, 1997). It is arguable that the sources of collaboration also apply to ESI.

The first source of problems is the buyer-supplier relationship itself. Unclear agreements or diverging expectations of scope and responsibility on collaboration as well as resistance to

[3]See Chapter 1: Motivation.

sharing proprietary information can keep the collaboration from working efficiently and effectively. These problems occur out of a false establishment of the relationship underlying the collaboration. Trust, commitment and effective communication are benefits of high-involvement and long-term relationships, and failure to trust or commit can even become a collaboration-preventing risk for potential participating companies. On the other hand, there are situations in which it is necessary for the buying company to collaborate with new suppliers to access, for example, a new technology. Such relationship problems can arise easily in project-based industries based on their discontinuous nature.

The second source of problems in ESI is the supplying company. Suppliers may not be able to collaborate properly and lack in-house technical capabilities. These problems occur when the assessment of suppliers is focused on the supplier's price rather than his or her technological and innovative capabilities. If the supplying company lacks collaborative skills, focused supplier development and support can moderate the problem. A second sort of supplier-caused problem can occur when the supplier only shows limited commitment to building long-term relationships and subsequently to participating in supplier-involvement activities. Suppliers with a high demand for their work may not be interested in committing to a high-involvement relationship and aligning activities for a particular project when the buying company does not offer special advantages to the supplier in return.

The third source of ESI-problems is the buying company itself. Firstly, problems can arise when the company does not know when, and and for what a supplier should be involved because the buyer lacks a clear involvement strategy and process. For example, the company may involve suppliers of components that are not necessary or may involve the suppliers at the wrong time. The employees of the departments affected by the supplier's involvement may even try to erect barriers to the suppliers if they feel their jobs are threatened or because of the not-invented-here syndrome.

3.5.5 Success factors for supplier involvement

Several studies examined the success factors of supplier involvement and models how to involve suppliers effectively and efficiently. The varying results of these studies suggest that the process of supplier involvement is not understood completely or that successful supplier involvement is such a complex system that it can only be analysed for specific cases. Different success factors were identified based on the different sources of problems discussed

in chapter 3.5.3. Some researchers focus on inter-relational and social success factors, while others concentrate on organizational and process factors on the buyer's or suppliers' side. Still, some success factors have been identified in studies on supplier involvement. Based on the various studies, it seems very likely that successful supplier involvement emanates from the buyer-supplier relationship, processes and organizational issues and the companies' ability to collaborate.

The findings of Petersen et al. (2005) offer an example of the relational inter-company focus on successful supplier involvement. They describe supplier involvement as a function of three parts: firstly, an effective supplier selection process, secondly, joint establishment of business performance metrics and targets for the project and thirdly joint establishment of technical performance metrics and targets. Van Echtelt and Wynstra (2001) focused on the organizational success factors of the buyer's side. They describe successful supplier involvement as a system of three issues. The first is identifying specific processes and tasks that need supplier involvement, the second is forming an organization and processes that enable supplier involvement and third is staffing the organization with people who have the commercial, technical and social skills needed to facilitate supplier involvement.

Liker et al. (1996) empirically identified process and business infrastructural issues that are important for successful supplier integration. Several other researchers have confirmed these issues. Process issues include which suppliers to involve (Handfield et al., 1999), the degree of suppliers' responsibility for design (Handfield et al., 1999; Petersen et al., 2005), when to involve suppliers (Handfield et al., 1999; Petersen et al., 2005), inter-company communication, integrative mechanisms and supplier membership in the project team (Gadde and Snehota, 2000). Business infrastructural issues include the role of supplier assessment (Carr and Pearson, 1999; Hoetker, 2005; Spekman, 1988), the role of inter-company relationships and alignment of organizational objectives with outcome (Gadde and Snehota, 2000; Gadde, 2010; Ragatz et al., 1997). Since this work focuses on early supplier involvement to enhance the utilization of suppliers' knowledge, social problems such as improving communication and relationships will not be analysed further. Of these success factors, supplier selection seems very important, since field development projects are very long-term and the decision of which supplier to involve early therefore seems very important.

3.5.6 Supplier selection for ESI

Selecting the right suppliers to participate in ESI requires strategic supplier assessment and is very important for effective use of suppliers' knowledge. It is important to distinguish common supplier selection from strategic supplier assessment. While common supplier selection as is used in purchasing activities includes criteria such as price, quality and delivery, strategic supplier assessment includes additional criteria such as degree of familiarity, previous level of involvement and engineering capabilities. The focus of strategic supplier assessment is to achieve alignment in suppliers' cultural/behavioral and technical capabilities and the buyer's needs (Petersen et al., 2005).

In an ideal world, a buyer's supplier selection for ESI would mean selecting among suppliers that qualified for ESI through common experiences in development projects and that are part of a high-involvement buyer-supplier relationship. In this setup, the buyer knows suppliers' capabilities and goals regarding collaboration, and the buyer trusts the supplier. Unfortunately, sometimes early involvement of a supplier is necessary in terms of its knowledge or technology, but the particular supplier has never been part of the buyer's projects and thus there is no relationship at all. Also, when suppliers and their capabilities are known, it is important to select the 'right' supplier to ensure the benefits of ESI. As previously mentioned, establishing a high-involvement relationship to lay groundwork for ESI is resource expensive. The potential benefits must justify the effort.

Therefore, at the beginning of strategic supplier selection, the areas and leverage points need to be identified at which such relationships and ESI make sense (Spekman, 1988). Afterwards, both Spekman (1988) and Handfield et al. (1999) describe strategic supplier selection as a process of two phases. The first is the general assessment reviewing all suppliers on their quality, price and delivery and on the upside of increasing the involvement of a specific supplier. The goal is to build a pool of potential strategic suppliers that are at least useful in terms of involvement, competency, reliability and capacity. The second step is an even more qualitative assessment of the suppliers on the short list. Spekman concludes that it "would be impossible to list all criteria needed during selection process" (1988:80). He identifies the following issues that need to be considered in this assessment.

- Suppliers' commitment for high-involvement relationship and therefore to alignment in business and technology

- Suppliers' ways of dealing with sensitive and confidential information and how proprietary information is shared
- Suppliers' willingness to share their future plans
- Suppliers' willingness to participate early and therefore to invest resources
- Suppliers' ability to cooperate in the needed way
- Suppliers' understanding for buyer's technical problems
- Suppliers' real technical and business capabilities
- Suppliers' demand and assurance of partnership

Even though the second phase may seem to be a fuzzy assessment strategy, the outcome is detrimental to establishing high-involvement relationships and ESI.

If the buying company needs a technological impact through ESI from a company with which it has no relationship at all, Handfield et al. (1999) provide a supplier selection model that bases on the strategic assessment issues that can be used to determine whether and how to involve the supplier. They add a risk assessment of the potential supplier to Spekman's strategic supplier selection criteria. In the first step, the suppliers' history, prior experience and industry reputation are reviewed. If the supplier cannot provide an acceptable history, the buying company has to pre-qualify the supplier. Pre-qualification means assessing the base requirements of cost, technical capability, and capacity and ability to meet the development schedule to minimize risk. If the supplier fails in this first risk assessment but provides critical technology and know-how, the company should support the supplier in its corporate development until the requirements of the pre-qualification are met. The second risk assessment is on suppliers' technology roadmap and their alignment to the buying company. If the technology roadmaps are aligned, the supplier can be considered a potential high-involvement relationship and ESI candidate. If the supplier is not aligned with the buyer's technology roadmap or is not willing to align, the critical technology supplier is still considered for the specific project, but the buying company also has to look for other long-term sources of this technology.

Because this supplier selection process can be very time-consuming and could probably cause delays, it seems useful to permanently select suppliers for ESI and to foster those relationships and guide the suppliers' corporate development.

3.6 Summary of the literature review

In this chapter, the main points of the presented literature are summarized with a focus on the statement of the problem and the presented theory and concepts.

1. The make-or-buy-decision in the petroleum industry

The literature review into the make-or-buy-decision in the petroleum industry leads to the conclusion that the industry offers advantages in both vertical integration and outsourcing, but for meeting the various needs in the field development, outsourcing is the better choice, especially when considering the advantages of buyer-supplier collaboration.

2. Buyer-supplier-relationship

The literature review on buyer-supplier relationship provides information about different kinds of relationship in general and specifically in terms of project cooperation. Also, the contributions of high-involvement relationships are discussed. The literature findings suggest that a high-involvement approach is necessary to gain the advantages of inter-company collaboration. Collaboration through a high-involvement relationship particularly provides the access to suppliers' knowledge and innovativeness and can contribute substantially in solving the buyer's problems or improving its operations.

3. Utilization of suppliers' knowledge

The literature review explains the usability and marketability of knowledge and its strategic relevance as a competitive advantage as well as different forms of knowledge management. The conclusion is that the kind of knowledge pursued through high-involvement relationships can be defined as know-how, and it represents a form of tacit knowledge. In this case, know-how is characterized by the combination of specified coded knowledge extended by adaptability. The conclusion is that for the operator, suppliers' know-how is the driving factor for collaboration, and the knowledge management approach of 'exploiting' is more suitable than 'exploring' to utilize suppliers' know-how.

4. Collaboration and supplier integration

The literature review provides definitions of collaboration and supplier integration and of different kinds of collaboration. Also, coherence between collaboration and integration is reviewed. The conclusion is that collaboration and supplier integration is necessary to enable

the benefits of high-involvement relationships to key suppliers on a project and company level.

5. Early supplier involvement

The literature review distinguishes between supplier integration and supplier involvement and defines early supplier involvement as a concept. The possible advantages and disadvantages of the concept in general and especially as related to the utilization of suppliers' know-how in petroleum field development projects are reviewed. ESI enables the possibility of achieving a substantially higher outcome of a problem through more efficient and effective utilization of suppliers' know-how at an overall lower project cost. Also the problems and success factors for using ESI in development projects are examined. Problems can be mostly avoided through a high-involvement and long-turn relationship. Finally, the specifics of assessing suppliers' capability for ESI are reviewed.

4 Analysis

The first part of the next section presents the findings of the semi-structured interviews summarized into four main topics. The findings are then analysed in the second part of the chapter.

4.1 Findings of the research

The findings of this study are the results of the coding part of the grounded theory approach and are summarized in categories for further analysis in the next part of this chapter. The study developed four categories relevant to the statement of the problem: the operator-supplier relationship, collaboration in development projects, use of suppliers' knowledge and ESI in field development projects. The participants are only described briefly because they asked to remain anonymous. As stated previously, six companies participated in the research. Within these six companies, two are field-operating oil companies and four are technology supplying companies. Details about the interviewees are summarised in Figure 7.

Interviewee's Job Title/Description	**Company Description**
Project Manager—Topside Engineering	Large international oil operator with several large fields in Norway
Development Engineering Manager—Capital Projects	Large international oil operator with several large fields in Norway
Technical Project Manager	International oil operator with few rather small fields in Norway
Senior Project Engineer—Front-end Engineering	Large Norwegian supplier in the drilling, welling and subsea fields
Senior Project Manager—Drilling Technology	Large Norwegian supplier in deep-sea drilling and welling
Project Manager—Subsea Pump Systems	Large Norwegian supplier with subsea technologies focus
Senior Project Manager— Advanced Rigging Methods	Norwegian supplier in structures, piping and advanced rigging methods
Project Manager—Remote Subsea Equipment	Norwegian supplier in structures, piping and advanced rigging methods

Figure 7: Research Interview Participants

4.1.1 Operator-supplier relationship

The operator-supplier relationships at the company level are characterized by the perspective on relationship, the regularity of the cooperation and the contractual bonding of the two sides. The interviewees reported both long- and short-term relationships as well as close and arm's-length relationships. The participants distinguished relationships as relationships on a personal level between suppliers' and operators' employees and between the two cooperating companies. When they were asked specifically about the relationship between the companies, they described the contractual bonding between the companies as their relationship. The frame contracts and projects with long duration like field development projects were described as long-term relationships, while stand-alone projects like R&D projects were described short-term. In terms of close or arm's-length relationships, the range of answers is mixed. Some interviewees describe close relationships and others arm's-length's relationships to suppliers or operators.

Operator interviewees in particular divided relationships into two categories: highly standardized and lower standardized contributions of the suppliers. For example, one participant stated, "You can call the relationships for example with topside-building companies definitely arm's length, but when it comes to more complex areas, our company is working very closely with the supplier". Another operator reported that the company's relationship with the suppliers changed during its development from a drilling company to a field operating company, especially through contracting with a main contractor for field development. "When we did drilling earlier, we invited our potential suppliers to a major meeting and informed them about our strategy so they were aware of what is coming up and to discuss potential solutions with us upfront. Now it is more difficult because we are not hands-on anymore, and our main contractor is responsible for the main engineering packages".

Another finding is that law and company regulations influence inter-company relationships. An interviewee from the supplier side reported, "…so they can only ask for our ideas and input and then directly contract our solution and us until a certain limit. On larger contracts, this is not possible due to the legal difficulties and the obligation of the tendering process".

Contracts, tendering and competitive bidding are mentioned very frequently to describe the level of cooperation. The contracts used in the Norwegian petroleum industry are described as

very detailed in the performance description and also often include complex options depending on how the project develops. The operators reported that they try to distinguish between standard technology suppliers and more complex and project performance-related suppliers. For standard suppliers, frame agreements used on different projects are set, while in the latter case, different cooperation contracts can occur. Furthermore, if the operator faces a specific problem and needs a specialized supplier to design a solution for it, the operator asks its technologically capable suppliers to propose solutions and contracts with them for R&D standalone projects.

The differences in the requirements of field development projects seem to impact the operator-supplier relationship, too. A project manager employed by the larger operator said, "When we examine the opportunities of developing a field, we do the main work in-house because we have the knowledge and experience, but sure, there are differences in the challenges between a potential field in the arctic and the gulf of Mexico, for example. Therefore we need suppliers with experience and know-how in these regions; then we look for smaller, local suppliers instead of worldwide operating ones. But this makes it difficult to build up a long-term and high-involvement relationship because the projects in the regions are irregular." Another finding is that supplier assessment is very important for operating companies. All possible suppliers have to pass through a supplier assessment process similar to the assessment approaches found in the literature review, before they can participate in tendering activities.

A third finding is the importance of an overall win-win approach on operator-supplier relationships in the Norwegian oil and gas industry. When asked why highly detailed contracts are used so frequently instead of establishing a more open and partner-like collaboration with suppliers, the perspective on relationship becomes an issue. The participant from the smaller operator reported, "For years I am looking over my shoulder and looking for holes in the contracts the supplier could use to have leverage on us". Another interviewee reported. "We had to award contracts for three similar projects and we contracted it to three different suppliers. We did this to avoid leverage on us, this would have been too risky." When asked specifically about the relationship with a key technology supplier and the possibility to build up a trusted relationship to involve him early, the risk of being dependent on him was reported as too high. For example, one interviewee from the larger operator stated, "If we would invite a key-technology supplier too early in a project, he surely would

become the sole supplier in the end of the day, and then he would charge us heavily for it." The participant from the smaller operator stated, "We have to establish a win-win mentality in the industry, especially when we look on the upcoming challenges in developing the smaller fields." In conversations with the other project manager of the larger operator, the interviewee did not raise this topic, but when asked specifically about it, he said, "No, I don't see it as an industry problem that every company tries to make his share."

4.1.2 Collaboration and cooperation in development projects

The findings on collaboration and cooperation in development projects discovered in the research interviews are categorised into three main groups. The first is about the separation in the treatment of different suppliers, the second is about the kind of collaboration and the reason for it and the third is about timing of supplier involvement.

The coding of the research interviews indicates that there is a bright variety of cooperation in style. An interviewee from the larger operator stated, "Key technology suppliers are handled differently than standard equipment suppliers. Because of economic reasons, we try to contract as many suppliers as possible on frame agreements. But if we need a specialized solution, we have to develop it together with the supplier". Overall, the participants described the main character of cooperation in the Norwegian oil and gas industry as an operative-focused collaboration. Furthermore, interviewees described contracts as the basis of collaboration instead of interdependency and long-term relationships. On the other hand, some suppliers reported of R&D projects emerging out of previous cooperation aimed at further developing a specific technology that the operator would like to use later on. The interviewee of a major multidisciplinary supplier stated, "Most of our R&D projects are based on previous cooperation with a customer. In these projects, the customer funds us to further develop our equipment".

Another finding is that overall, the interviewees reported an open, trustful and effective environment when it comes to cooperation in the industry on a daily basis. But also, one research participant from a smaller operator did report, "I do have the feeling I must look over my shoulder when doing business with my suppliers because of lacking trust. The collaboration within the boundaries of the contracts is good, but in my opinion, we do not have enough trust in the industry to go further with collaboration at the moment".

A distinction between standard technology/equipment/service suppliers and success-relevant suppliers is observed in the research interviews in all cooperation topics, but in terms of timing and form of integration, this separation becomes fundamental. Suppliers of intense technology or success-related suppliers are more often integrated through cross-company project teams. One interviewee from the larger operator stated, “In the engineering phase, we work very closely together with some suppliers. Often the development goes back and forth, and therefore our people become involved in their project organization while developing a solution.” The interviewee from the smaller operator stated, “We have a strong involvement of our people in the main contractor’s project organization. They collaborate on a daily basis with the contractor’s engineers; this is to tackle problems when they occur and watch the project progress”. Besides these situations, the supplier participants reported collaborating in cross-company project teams with larger suppliers and sub-suppliers. A participant working on remote subsea technology said, “Sometimes we involve engineers from our suppliers in our team and figure out problems to perform a good solution for the customer”. In general, the research interviews suggest that supplier involvement through building cross-company project teams is not very common in the early planning phase of Norwegian field development projects, but is more common in problem-oriented sub-projects.

The timing of supplier involvement in an operator’s projects is mainly reported to be problem-oriented instead of process-oriented. Also, the in-house knowledge and capabilities of the operators seem to define the point and time of supplier involvement. Some operators reported performing the front-end phase completely in-house, while others reported outsourcing the whole process or parts of it to suppliers. In general, the coding of the research interviews with operator managers suggests that they prefer to develop the project in-house and contract suppliers for the detailed engineering and execution phases. A participant of the larger operator reported accordingly, “We have the capabilities to do the whole early phase of a development project in-house; the feasibility studies, the main concept and the assessment of needed technology, basically everything prior to the contracting phase for execution. This is mainly because we try to use proven technology in our projects only; this is necessary because of the economic side of the project planning. We only involve suppliers before we enter in contracts for project execution if we lack experience in a specific environment. Then we look for a local supplier with a lot of experience in the specific problem area.”

4.1.3 Use of suppliers' knowledge

The research interviews indicate that the use of suppliers' knowledge and expertise is the main reason for cooperation in the operator's field development projects. Developed solutions and the know-how of key technology suppliers represent the main contribution to an operator's projects. An operator-employed interviewee summarized this issue: "We involved them because they are the experts—we do not have the competence in house. They work in this environment all the time". One interviewee employed at a leading technology supplier responsible for FEED-study engineering states: "We work for the oil companies in the front-end phase of the projects depending on the knowledge of the oil companies. If they have some ideas themselves, we help them in the further engineering. But they also come to us with blank paper and ask us to propose a concept. This depends on their experience and in-house capabilities".

Another finding is that operators' use of suppliers' knowledge tends to be problem-oriented instead of process-oriented. One interviewee from the operator group said, "If we face an unknown problem, we take a look around our supplier base and assess them for the problem and ask them to hand in their ideas for a solution". The contribution of a supplier based on knowledge is also described by another operator-interviewee: "We had a challenging field some years ago with high temperatures and high pressure where we needed a supplier to develop a solution for this environment to make drilling possible. The supplier engineered a working solution, but we had to pay a fortune for this". Furthermore, the interview added, "We also work with R&D institutes and universities to develop new technologies. The difference is that the institutes propose projects we should fund, but if we need a certain new solution to a problem, we go to our suppliers". To use suppliers' knowledge, R&D contracts are reported to be very common. These contracts can emerge out of previous cooperation but also are used in general to develop new technology to use in later development projects. A supplier-participant said, "For example the operator comes to us and describes a specific problem and expects us to find a solution for this. But these are stand-alone R&D contracts then". An operator-interviewee noted, "A lot of new technology gets developed in the industry in collaboration with suppliers."

4.1.4 Early supplier involvement

The research interview findings fell into three main categories on early supplier involvement. The first is the general status of ESI in the Norwegian oil and gas industry, the second is

about the potential advantages and disadvantages the participants see and the last is about thoughts of the future importance of ESI in development projects.

When the participants in the research interviews were presented with the concept of ESI, most of them recognized it, and many also connected it to the automobile industry. Although in general, the involvement concept as a form of collaboration in which the operator or a main contractor acts as a system integrator of suppliers and their specific contributions to execute a project is used in the industry, the participants mostly reported that collaboration in the form of ESI is unusual. The exceptions are the main contractors or engineering companies that are hired to develop the overall concept or perform feasibility or FEED-studies. One operator-interviewee stated, "Until the specifications are set and the overall technical concept is chosen, we usually do not involve suppliers. The only situation I could imagine to do this is when we would have to develop a very challenging field in an geologic area we have no experience in; but we avoid these kind of fields, we only develop fields where we can use proven technology".

Participants in both groups report possible advantages of ESI in enhancing the use of suppliers' specific knowledge. One supplier-interviewee said, "If we were involved in the early phase, we could influence the operator's thoughts on the technology assessment for example and develop a better solution for the project, because our and the operator's view would be combined. If they involve us later, our influence is smaller and we have to build upon decisions already made". Another supplier-interviewee stated, "If we're involved early, we would consider things that are easy to implement in the early phase but hard later on. Operators cannot think of all eventualities the platform will face during the lifetime in our specific area, but we can". One operator-interviewee stated, "Yes, sure, amongst our suppliers you can find a lot of good people with good ideas and therefore involving them early could help a lot to use their knowledge better, but the question is at what cost. Because if we involve them as early as possible and let them have influence on our technology assessment, for example, they surely would become our sole supplier at the end of the day. And then they would play their power position. That is a major disadvantage. Therefore, it is hard to say in the beginning whether the contribution of involving the supplier early would overweigh the disadvantage of dependency in the end." Another operator-interviewee supported that, mainly pointing to the missing external market when the suppliers would become involved in the technical assessment.

In the overall discussion about ESI in projects, the interviewee from the smaller operator stated, “At the end of the day, it is a question of trust and dependency. And this trust is built upon a long and constant period of working together. In our industry, we are mostly working on a project basis. Sure, we are doing business with the same companies in different projects, but in my opinion, the industry has not come so far yet. In my opinion, we do not have the needed trust and mentality within the industry to involve suppliers in the very early phase of our projects”. An interviewee from the larger operator stated, “I can imagine that there will be more situations in the future where some technology suppliers are needed to bring in their knowledge very early to analyse whether a field is possible to develop in a technology sense. The easy fields are developed, only smaller and more challenging fields are left in the NCS, so therefore involving suppliers early could become more necessary for us”.

4.2 Analysis

In this chapter, the findings from the research interviews are analysed on basis of the concepts and theories presented in the literature review. Firstly, the findings on buyer-supplier relationship and collaboration on company level and project-level are analysed. Then the utilization of suppliers' knowledge in operator's projects is evaluated. Finally, the findings on ESI are analysed.

4.2.1 Buyer-supplier relationship on company level

Gadde and Snehota's theory identifies four kinds of inter-company relationships with different combinations of low/high regularity and low/high involvement. The two scholars, as well as Ford (Ford, 2011; Gadde and Snehota, 2000), suggest that the inter-company relationship impacts the outcome of collaboration in general and the utilization of suppliers' knowledge in particular. Both scholars link long-term and high-involvement relationships with improving utilization of suppliers' knowledge. In this context, the findings on operator-supplier relationship of the research interviews are analysed. Interviewees reported on company level of low and high regularity and low and high involvement relationships and different treatment of suppliers depending on their contribution and importance to the project. This is reasonable when size and complexity of the development projects are considered. On the other hand, the operator-participants did not report on mutual adaptions to key suppliers on a company's process-level beyond informing some of them of the company's plans for upcoming projects. This is interesting because in theory, the absence of mutual adaption of activities would characterize low-involvement relationships, but the participants explicitly report on high-involvement relationships, too. This also indicates the absence or at least a low level of supplier integration in sharing information as defined in chapter 3.5.

There are two possible explanations for this. Firstly, the findings on the perspective on relationships and an overall win-win approach suggest that the potential benefits of mutual adaptions and high-involvement relationships on the company level, in particular better solutions at lower costs, are less emphasized than the disadvantages, in particular dependency on suppliers. The second reason is the setup of the development projects. The participants reported using standard equipment/services when possible and non-standard equipment/services only when absolutely necessary. This leads to a higher regularity at the low-involvement cooperation and a lower regularity on the high-involvement collaboration. The low regularity of cooperation with suppliers offering the potential for better solutions

makes mutual adaptions on a company-process level impractical. The setup of the project also explains the high use of tendering activities and contracts in general. The participants stress the meaning of contracts, which suggests that in regard to the definitions of cooperation and collaboration in chapter 3.2, there is no collaboration on a company level between the operators and suppliers. At the same time, the interviewees report of 'close collaboration', which indicates a postponement of high-involvement relationship behavior due to the character of cooperation into the project level after contracting. If the field development project's duration is regarded additionally, it is reasonable that mutual adaption of activities typical for high-involvement relationships occurs within project collaboration instead of company collaboration like in a line-organized company i.e. within the automobile industry.

4.2.2 Collaboration within the development project

The form of cooperation within the development projects also influences the utilization of suppliers' knowledge. Collaboration is characterised by Spekman (Spekman, 1988) as long-term collaboration, bilateralism, mutual commitment and balanced power. As stated above, these levels are more applicable to the cooperation of suppliers and operators within the development project. According to the findings, the balanced power and mutual commitment in particular seem to be substituted through the contracts for development projects.

To analyse the utilization of suppliers' knowledge in collaborative development projects, it is useful to examine the connection between the configurations of collaboration used in the literature on the one side and the findings on these topics on the other side.

In terms of typical petroleum project setups, the findings show project-based cooperation with either individual contracting of every supplier or contracting one EPCI contractor. This correlates with the typical petroleum industry project forms developed by Olsen et al. (2005) described in chapter 3.1. To examine the influence of different cooperation forms, it is also useful to analyse the findings about the alliance-configurations model for project development and execution developed by Hobbs and Andersen (2001). The model designates four project configurations based on the degree of front-end internalization and inter-company relationship.

		Dynamics of sponsorship (front-end)	
		Internalised process	Coalitional process
Dynamics of execution	Arm's length	Quadrant 1 Traditional sponsorship	Quadrant 2 Partners in ownership
	Relational	Quadrant 3 Partners in Design and Execution	Quadrant 4 Relational development and execution

Figure 8: Hobbs and Andersen's Model of Configurations of Project Development and Execution (2001, p. 466)

The findings suggest that in field development projects, the cooperation configuration 'Partners in Design and Execution' is mainly used. Some findings indicate that there is also 'Traditional Sponsorship' cooperation with low-technology-contributing suppliers on the one hand and 'Partners in Ownership' cooperation in cases of EPCI turnkey projects on the other hand. Because these two cooperation settings are not useful for analysing the statement of the problem, they will not be discussed further. In cases of the 'Traditional Sponsorship' form, cooperation is not collaborative enough, and in cases of EPCI projects, it seems that this only provides a postponement of operator-supplier cooperation because the EPCI contractor in simplified terms becomes the 'operator' of the development project.

Further analysis of the findings on cooperation and relationship under the classification of 'Partners in Design and Execution' shows that 3 of 4 subcategories mentioned by Hobbs and Andersen are found. This is very important because it explains that after contracting with a supplier, cooperation becomes a high-involvement relationship with a collaborative approach to utilize suppliers' knowledge.

According to the research findings, suppliers of basic contributions to the project are handled through 'frame agreements', which theoretically enables project efficiency and also the possibility of ESI through familiarity with the operator's project, according to Hobbs and Andersen. The findings on R&D operator-supplier projects show that the subcategory 'One-off Integrated Project Team' is used frequently, too. In this kind of cooperation, cross-

company project-team cooperation is used on a power-balanced level, which provides an opportunity for ESI.

The findings of the research interviews on FEED activities, concept engineering and in some situations EPC contracts need to be analysed in more detail. On the one hand, the findings indicate that these cooperation represent the high-involvement project sub-concept called 'Partnering' within the concept 'Partners in Design and Execution'. Because of early integration and the focus on using suppliers' knowledge in the early phase, these collaborations could be regarded as ESI. On the other hand, this collaboration is only ESI when the supplier is involved earlier than usual. A supplier regularly involved to develop a FEED study is not involved early, but rather at the usual point, whereas a supplier of drilling technology who is brought in to assess the feasibility of drilling in a specific field is involved much earlier than usual.

The only sub-concept of 'Partners in Design and Execution' that the analysis of the findings does not support is the 'sticky-informal networks' approach. The importance of contracts to exactly describe the scope of cooperation and the findings on the 'win-win-mentality' in the industry discussed earlier indicates the absence of this concept of collaboration in the industry.

The following points are the groundwork of the further study and the main results of the analysis on operator-buyer-relationship, project setup and collaboration within development projects.

- The buyer-supplier relationship in the Norwegian petroleum industry is project-oriented instead of process-oriented and therefore lacks mutual adjustments of activities on the company level, which normally is counter to high-involvement relationships and collaboration.
- Supplier integration in terms of sharing of information is used infrequently on a company level but frequently on project level.
- In setting up development projects, the front-end phase and overall project management is mainly done in-house or internally except in turnkey EPCI-projects.
- The high-involvement and collaboration aspect needed to enable the benefit of operator-supplier collaboration and especially the use of suppliers' knowledge is found partly at

project level through the high-involvement 'Partners in Design and Execution' configuration of cooperation within the development projects.

- Since overall project management remains internalized, use of suppliers' knowledge is problem-oriented since the operator involves mostly one supplier to solve a specific problem area.

4.2.3 Management and utilization of suppliers' knowledge within development projects

Analysing the type of suppliers' knowledge in the collaboration and the knowledge management of the operators helps to clarify the reason for collaboration and the advantages of involving suppliers early in field development projects. The participants mainly stated that key technology suppliers are used because of their knowledge and experience in handling special circumstances. All statements focused on problem solving through knowledge and experience. These findings indicate that suppliers' knowledge is that referred to by Teece (1998) as know-how. This is reasonable, since Teece defines know-how as knowledge about how to accomplish something. He also states that only know-how is a marketable asset of a company. Since by definition know-how is specific codified knowledge extended by knowing how to use it under different circumstances, it is also tacit. Therefore it is reasonable that the operators have to involve suppliers in their projects to utilize the latters' know-how.

The second conclusion drawn on these findings is about operator's knowledge management. The findings suggest that operators use suppliers' know-how in the 'dynamic capabilities' approach to knowledge management. This can be concluded through the finding that operators mainly involve key suppliers when their in-house capabilities are not sufficient to solve specific problems or to work in specific geographic areas. The findings also suggest that the goal of operators in the style of Grant and Baden-Fuller (2004), that is, primarily to access or 'exploit' suppliers' knowledge instead of acquiring or 'exploring' suppliers' knowledge. These findings enable the conclusion that the collaborative level necessary to use the concept of ESI to enhance utilization of suppliers' knowledge is embedded in the Norwegian petroleum industry's development projects.

4.2.4 Early supplier involvement in Norwegian petroleum field development projects

Early supplier involvement as described in chapter 3.5.1 by definition takes place before regular operations. Petersen et al. (2005) identified five points of involvement within the pre-operation phase of a project.

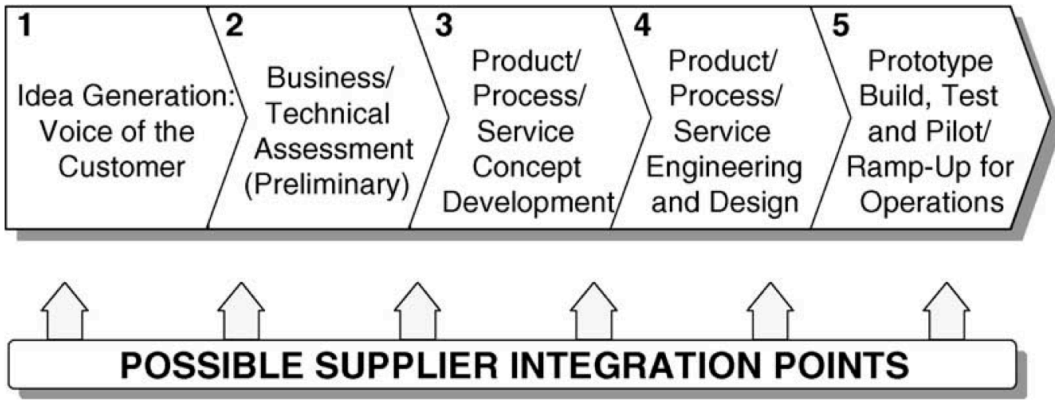

Figure 9: Possible Involvement Points by Petersen et al. (2005)

According to the findings of the research interviews, suppliers are involved at different stages, depending on their contribution to solving problems that arise during these stages. While the interviewees report of some suppliers being involved in the third phase to develop concepts for the project, most reports suggest that operators mainly use suppliers in the fourth phase to engineer sub-parts of the project identified by the operator itself during previous phases. While Petersen et al. argue that supplier involvement is possible at each of the five phases, these findings support the argument of Mikkola and Skjøtt-Larsen (2006) that the project leading companies see the activities in these stages as their core competencies. The findings about operators' need to avoid dependency on a sole supplier also support this position.

Also the findings about the utilization of ESI in interviewees' projects suggest that they do not see the need to use ESI in their projects. This is because the interviewees link ESI mainly to the first two stages. and the involvement of suppliers in the three later phases is so common that they do not perceive that as 'early' supplier involvement. On the one hand, the literature suggests that involvement of suppliers in any of these five stages can be regarded as ESI when it takes place during the pre-operation phase. In field development projects, the involvement of suppliers in these pre-operation 'early' phases noted in the interviews usually was the regular timing for these suppliers. Therefore, 'early' supplier involvement in field development projects would mean involvement of suppliers regularly involved in phase 4 and 5 in phases 1 to 3. Whether this perspective can be adapted in this study is arguable.

5 Discussion

The research questions underpinning this study are answered through a discussion of the research results. First, the research question "How does ESI interact with the utilization of suppliers' knowledge in operator's petroleum field development projects?" is discussed. Next, the second research question, "How can ESI be used in petroleum field development projects to benefit most of suppliers' knowledge?" is discussed.

5.1 How does ESI interact with the utilization of suppliers' knowledge in operator's petroleum field development projects?

The effects of ESI on the utilization of suppliers' knowledge are reported partly based on the literature findings and partly on thoughts of the participants, but as pointed out in the previous chapter, the interview findings suggest that ESI is not used in the Norwegian petroleum industry. However, it is likely that the participants based their thoughts on their experiences of similar forms of collaboration. Therefore, their thoughts on the effects of ESI on use of suppliers' knowledge are valuable in the analysis, too.

The first relevant point is that nearly all participants see the operational and short-term advantages of ESI on the utilization of suppliers' knowledge to achieve a better outcome for the project. In particular, the suppliers stating that if they were involved early, they could make suggestions for better technology assessment instead of having to work based on the decisions the operator has already made. This suggests an improvement of the solution based on greater knowledge in a specific technology area. Also, the suppliers noted their ability to foresee the eventualities that require consideration in the concept phase or technology assessment decisions better than the operators. The operators supported these positive effects of ESI on the use of suppliers' knowledge when they stated that they collaborate with suppliers mainly because of their knowledge and expertise. Suppliers' knowledge would be used more efficiently through early involvement, which theoretically improves the project cycle time because the supplier helps do it right the first time, specialized technology is used and also internal project complexity is reduced. On the other hand, these effects do seem to be realized through the current form of cooperation, probably because of the difference in the main set up of the industries. While ESI and its operational advantages mostly are observed in 'New Product Development' projects of process-oriented industries, the project orientation of the petroleum industry would seem to realize similar advantages because of the outsourcing

activities and sub-projects to suppliers. As mentioned before, the difference is that in process-oriented industries, the contributions of suppliers can be seen as ESI because they are involved regularly in the operational phase of the industry. Suppliers that contribute in early phases of operator's field development projects are mostly regularly involved this early because early participation is part of the services they routinely offer, at least as observed in this study.

With the presented literature in mind, the ESI-concept could, when implemented on a company level, evoke several advantages in petroleum field developments, especially in terms of enhancing the utilization of suppliers' knowledge. Therefore, a project setup needs to be developed that overcomes the limiting factor of deeper collaboration in the industry. Based on the findings, the limiting factor seems to be the operator's fear of becoming dependent and exploited by a sole supplier that is brought in too early. 'Too early' in this case seems to be in the technical assessment and the early concept design phases. Also the fear of being stuck with a supplier seems to be important. In summary, the benefit of using ESI to collaboratively develop a superior customized solution seems to be limited because lack of commitment to one supplier and the acceptance of interdependency. One operator especially supports this when stating that to realize the whole positive effects ESI has on the utilization of suppliers' knowledge, trust at the company level has to improve within the industry.

Overall it can be stated that this study did not find the utilization of the ESI concept in the Norwegian petroleum industry. However, the findings of collaboration in the development of projects suggest that ESI could have a positive effect on the utilization of suppliers' know-how. Also the findings of the research interviews support that to meet the need to develop more complex or smaller fields economically, improvement of operator-supplier collaboration in general and early supplier involvement in particular would be helpful.

5.2 How can ESI be used in petroleum field development projects to enhance the utilization of suppliers' knowledge?

On the one hand, the potential of ESI to enhance the utilization of suppliers' knowledge is approved theoretically and by the participants of the research interviews. On the other hand, the possible positive effects of ESI on the use of suppliers' knowledge do not seem to be realized in current collaborations. Therefore, the question "How can ESI be used on

petroleum field developments projects to enhance the utilization of suppliers' knowledge?" is discussed. The discussion involves three sub-questions.

1. Which suppliers should be regarded in an ESI approach to collaboration?
2. When should these suppliers become involved in the development project?
3. How should the project collaboration be designed?

The literature and the analysis of the research interviews suggest that not every supplier should be involved early. The effort would in most cases exceed the potential benefit, especially in terms of enhancing the use of suppliers' knowledge. The results of the analysis show that mainly suppliers of technology-intense and specific-environment-related know-how are appropriate for early involvement in the development projects. This is reasonable because high-technology activities like drilling, welling, information transmission and special experience in areas like deep water, arctic water, etc., can determine the success of the industry's development projects. To find these key suppliers, it would be useful to assess and select the suppliers in the manner described in chapter 3.5.5. Even though the contribution of suppliers of less success-relevant activities could improve outcomes through ESI, the complexity of the coordination of the number of involved suppliers would surely overshadow the improvement. The analysis further suggests that key suppliers are qualified for an ESI approach because of their technological and collaborative capabilities. Also it can be assumed that key suppliers hold a power position in the industry that arises from their contributions to the success of field development projects. Therefore, operators have to provide incentives beyond contractual bonding to persuade suppliers to commit to high-involvement relationships.

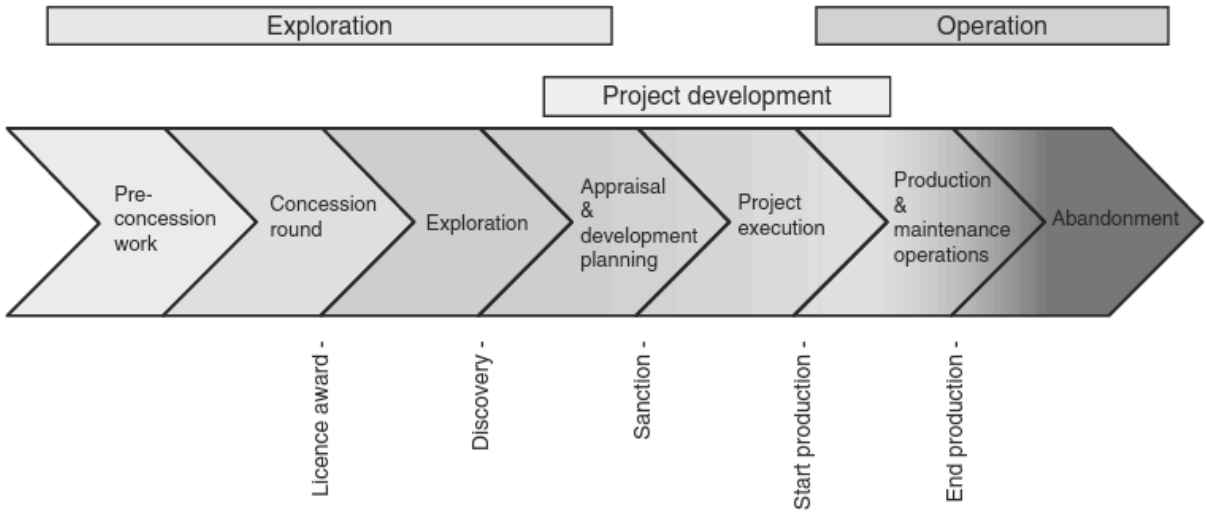

Figure 10: Stages of an Exploration and Production Venture, published in Petroleum Resources with Emphasis on Offshore Fields (Gudmestad et al., 2010: 143)

To define the point of supplier involvement most appropriate to enhance the use of suppliers' knowledge, the models of the stages of petroleum field development projects (Figure 10) and the model of possible points of ESI by Petersen et al. (Figure 9) need to be combined. The potential involvement points of suppliers occur after 'License Award' and end with 'Start Production'. The findings report at earliest involvement in the 'Appraisal and Development Planning' phase for concept development, but only after the operator's assessment of technology and determination of a general development concept. Mostly, suppliers become involved in the 'Project Execution' phase, of which the engineering and design activities mark the early supplier involvement. The later, main execution activities obviously have no early supplier involvement opportunities.

Suppliers' knowledge and know-how would significantly contribute to exploration and appraisal of fields and as well as in the following front-end stages, especially for the technology assessment and the overall development concept planning of a field. According to Wasti and Liker (1997), one main positive effect of ESI on the utilization of suppliers' knowledge is that it can reduce technological uncertainties reported in the research interviews. Subsequently, the main benefit could be that the operator could assess fields based on the suppliers' leading-edge know-how in several technology intense areas like drilling, welling and subsea experience. Furthermore, the combined ability to assess developing or improving the technology needed to develop a field that does not appear feasible on first view could give the operator a competitive advantage. Higher expertise could help develop both, fields in challenging environments and smaller fields more efficiently.

To achieve these mentioned advantages and provide incentive for key suppliers to commit to high-involvement collaborations, the form of collaboration used in the industry would need to change. Also, as discussed in the first research question, ESI in the current project form is limited to reported petroleum field projects because of the fear of becoming dependent on a sole supplier. To overcome these limitations, it could be useful to tie suppliers' financial outcome in the project to their success. Olsen et al. (2005) report an useful form of collaboration named 'project alliance'. Instead of building alliances with other operators, the operator would build joint ventures with key suppliers. Due to the irregularity and duration of field development projects, it would be useful for operators to establish joint ventures for each field they hold a concession on. The joint venture would be only for the development of the field, not its operation. The key suppliers would become partners in a joint venture; simultaneously, this kind of involvement would comply with the ESI concept.

Since the goal of using the joint venture form is mainly to provide incentive for suppliers' to align their goals with those of the operator, it is necessary to measure the success of the joint venture. Therefore, KPIs need to be developed to compare a regular outcome to the outcome of the joint venture. These KPIs could be based on a comparison of development costs of the field to estimated development costs or some similar yardstick. The detailed configuration of the joint venture model in general and the KPIs to measure success remain a problem for further research.

Overall, the further emergence of buyer-supplier collaboration in the form of early supplier involvement will depend on overcoming the fear of dependency on both sides by developing more trust and mutual commitment to collaboration. However, the concept of ESI holds very rewarding benefits for field development projects, especially in terms of enhancing the use of suppliers' knowledge.

6 Conclusion

The petroleum industry in general and the Norwegian oil companies in particular face several problems in upcoming field development projects. In particular, technical challenges inherent to the difficult environments of the Norwegian continental shelf and the challenges inherent to economically develop smaller fields fuel the need to rethink the field development process. In this thesis, I explored the enhancement of the utilization of suppliers' know-how by intensifying operator-supplier collaboration as one way to rethink the field development process and overcome these challenges. I believe that the thesis contributes valuable new knowledge in several ways. Firstly, the thesis provides new insights for practitioners of the Norwegian petroleum industry, especially by illustrating how intensifying their field development projects through early supplier involvement would lead to an overall better outcome. Secondly, the thesis provides new knowledge to academia about the transfer of the ESI concept, which mostly has been researched in short-term projects of process-oriented line organizations to long-term projects of problem-oriented project organizations.

Additionally, I structured the literature review chapter so that it is not only useful for the specific statement of the problem underlying this thesis, but so that it also helps newcomers to buyer-supplier collaboration, utilization of suppliers' knowledge and early supplier involvement understand its main dimensions and applications. Eventually, I hope this thesis be a further step for research into the topics of ESI in project organizations and the progress of operator-supplier collaboration in petroleum field development projects.

Statement of the problem revisited

In this section, I will briefly revisit the main statement of the problem and the research questions and argue how and to what degree I have answered them.

The main statement of the problem was to:

> analyse and evaluate whether and how early supplier involvement as a form of vertical collaboration affects the utilization of suppliers' knowledge in petroleum operators' field development projects using the example of the Norwegian petroleum industry.

The derived research questions follow.

> R1: How does ESI interact with the utilization of suppliers' knowledge in operators' petroleum field development projects?

R2: How can ESI be used in petroleum field development projects to enhance the utilization of suppliers' knowledge?

To elaborate on the main statement of the problem and answer the research questions, I thoroughly reviewed the relevant and adjacent literature and presented the results of this examination in the literature review section of this thesis. Therefore, the literature review explores relevant academic theories and concepts. The structure of the literature review leads to a theoretical overview of the statement of the problem in general. To examine the practitioners' view of the statement of the problem, I then conducted eight research interviews with capable employees of companies involved in field development projects of the Norwegian petroleum industry. While the sample of eight by no means gives general validity to the findings, the findings can be regarded as useful for discussing the research questions. I then discussed the research questions on the basis of the literature review and analysis of the research interviews.

The first research question is partly answered. I was able to evaluate the positive and negative effects of ESI on the use of suppliers' knowledge through the literature review and the discussion with the research interview participants. Unfortunately, the interviewees did not report on the use of the ESI concept in field development projects. The analysis suggests that mainly trust and reluctance to commit to a specific supplier are the limiting factors for ESI. However, the participants in the research interviews confirmed the theoretical findings on the effects of ESI on utilization of suppliers' knowledge, especially the positive effects. Mainly, it can be stated that ESI in general leads to a more effective and efficient use of suppliers' knowledge by realizing feasible and better solutions at the beginning of the project and therefore requires fewer resources. Specifically, suppliers' know-how would improve the overall field development concept, the decision-making ability of feasibility of field developments and the assessment of technology. The negative aspects are interdependency and the need to establish high-involvement and long-turn relationships with important key suppliers. Whether the theoretical advantages on the utilization of suppliers' knowledge will be realized in field development projects when ESI is used in the Norwegian petroleum industry is unfortunately not answered in my study because ESI is not used.

The second research question is answered by developing a model of a project organization to overcome obstacles and apply the ESI concept to field development projects to enable the positive effects of ESI on use of suppliers' knowledge. In summary, ESI operators need to

select suppliers with rates of success in solving complex problems of field development and involve them directly after they obtain a license. The collaboration should take the form of a joint venture with KPI-oriented success measurements to ensure mutual commitment to the collaboration in general and to the best solution in particular. Also, this kind of project organization would accommodate the fact that developing a long-turn and high-involvement relationship is difficult due to the irregularity of projects in the petroleum industry by eliminating the potential negative effect of interdependency.

Overall, the goals underlying this study were achieved. The status of operator-supplier collaboration in the Norwegian petroleum industry's development projects is elucidated in chapter 3.1 and especially in the analysis of the research interviews. The second goal, 'Investigate the positive/negative effects of ESI on the use of knowledge and know-how in projects', is achieved in section 3.5.3 and in the discussion of the first research question. The third goal, 'Identify areas and requirements for embedding ESI in projects for operators to benefit the most from suppliers' knowledge, is achieved in section 3.5.4 and 3.5.5. The last goal of the thesis, 'Make suggestions and recommendations for embedding ESI in the Norwegian petroleum industry's projects', is achieved in the discussion of the second research question.

Further work and prospects

The results of my study suggest different possibilities for future research. Firstly, due to the conducted research approach and its findings on the utilization of ESI in development projects, it would be interesting to conduct a representative survey to confirm the status of use of ESI in Norwegian field development projects. Secondly, it would be interesting to explore whether and how ESI is used in other project-organized industries, as I mainly found research about the application of ESI in more line-organized industries conducting 'New product development' projects. Thirdly, the suggested form of collaboration presented in the discussion of the second research question needs to be further developed, especially in terms of KPIs to measure the success of field development. Finally, it would be interesting to analyse in a representative sample whether ESI has a positive effect on the outcome of the petroleum industry's development projects at all.

In my opinion, early supplier involvement is a great tool for conquering the difficulties to developing challenging or small petroleum fields, and an even greater tool for accessing

expertise for determining whether a petroleum field is exploitable in a technological and economic sense. Therefore, collaboration based on inter-firm trust is necessary. The achievement of this high-involvement relationship in general and ESI in particular represents a great competitive advantage from a strategic perspective for the first oil company that puts them into practice.

List of literature

Alan Bryman and Emma Bell, 2011. Business research methods, 3rd ed. Oxford Univ. Press.

Appleyard, M.M., 1996. How does knowledge flow? Interfirm patterns in the semiconductor industry: Knowledge Flows in the Semiconductor Industry. Strategic Management Journal 17, 137–154. doi:10.1002/smj.4250171112

Bonaccorsi, A., Lipparini, A., 1994. Strategic partnerships in new product development: An Italian case study. Journal of Product Innovation Management 11, 134–145. doi:10.1016/0737-6782(94)90061-2

Brown, S.L., Eisenhardt, K.M., 1995. Product development: past research, present findings, and future directions. Academy of management review 20, 343–378.

Bruce, M., Leverick, F., Littler, D., Wilson, D., 1995. Success factors for collaborative product development: a study of suppliers of information and communication technology. R&D Management 25, 33–44. doi:10.1111/j.1467-9310.1995.tb00898.x

Carr, A.S., Pearson, J.N., 1999. Strategically managed buyer–supplier relationships and performance outcomes. Journal of Operations Management 17, 497–519.

Chima, C.M., 2011. Supply-chain management issues in the oil and gas industry. Journal of Business & Economics Research (JBER) 5.6.

Clark, K.B., 1989. Project Scope and Project Performance: The Effect of Parts Strategy and Supplier Involvement on Product Development. Manage. Sci. 35, 1247–1263. doi:10.1287/mnsc.35.10.1247

Cousins, P.D., 2005. The alignment of appropriate firm and supply strategies for competitive advantage. International Journal of Operations & Production Management 25, 403–428. doi:10.1108/01443570510593120

Crémer, J., 1995. Arm's Length Relationships. The Quarterly Journal of Economics 110, 275–295. doi:10.2307/2118440

Croom, S.R., 2001. The dyadic capabilities concept: examining the processes of key supplier involvement in collaborative product development. European Journal of Purchasing & Supply Management 7, 29–37. doi:10.1016/S0969-7012(00)00019-8

Das, T.K., Teng, B.-S., 2000. A Resource-Based Theory of Strategic Alliances. Journal of Management 26, 31–61. doi:10.1177/014920630002600105

Dowlatshahi, S., 1998. Implementing early supplier involvement: a conceptual framework. International Journal of Operations & Production Management 18, 143–167. doi:10.1108/01443579810193285

Dyer, J.H., Singh, H., 1998. The relational view: cooperative strategy and sources of interorganizational competitive advantage. Academy of management review 23, 660–679.

Ford, D. (Ed.), 2011. Managing business relationships, 3rd ed. Wiley, Chichester, West Sussex, U.K.

Forrest, Pearce, Lewe, Schroeter, Doerler, Walters, Kaushal, Besland, 2011. AT Kearney-Challenging the Integrated Oil and Gas Model.

Gadde, L.-E., 2010. Supply network strategies, 2nd ed. Wiley, Hoboken.

Gadde, L.-E., Snehota, I., 2000. Making the most of supplier relationships. Industrial Marketing Management 29, 305–316.

Grant, R.M., 1996. Toward a knowledge-based theory of the firm. Strat. Mgmt. J. 17, 109–122. doi:10.1002/smj.4250171110

Grant, R.M., Baden-Fuller, C., 2004. A Knowledge Accessing Theory of Strategic Alliances. Journal of Management Studies 41, 61–84. doi:10.1111/j.1467-6486.2004.00421.x

Guba, E.G., Lincoln, Y.S., others, 1994. Competing paradigms in qualitative research. Handbook of qualitative research 2, 163–194.

Gudmestad, O.T., Zolotukhin, A.B., Jarlsby, E.T., 2010. Petroleum Resources with Emphasis on Offshore Fields. WIT Press, SOUTHAMPTON.

Hagberg-Andersson, Åsa, Kock, S., Åhman, S., 2000. Managing Buyer-Supplier Relationships In A Supply Network-The Buyer's Perspective, in: Proceedings of the 2000 International Marketing and Purchasing Conference, Bath.

Håkansson, H., Waluszewski, A., 2014. Knowledge and Innovation in Business and Industry: The Importance of Using Others. Routledge.

Handfield, R.B., Ragatz, G.L., Peterson, K., Monczka, R.M., 1999. Involving suppliers in new product development? California management review 42, 59–82.

Handley, S.M., Benton, W.C., 2009. Unlocking the business outsourcing process model. Journal of Operations Management 27, 344–361. doi:10.1016/j.jom.2008.11.002

Hobbs, B., Andersen, B., 2001. Different alliance relationships for project design and execution. International Journal of Project Management 19, 465–469. doi:10.1016/S0263-7863(01)00048-5

Hoetker, G., 2005. How much you know versus how well I know you: selecting a supplier for a technically innovative component. Strategic Management Journal 26, 75–96. doi:10.1002/smj.453

Hoyt, J., Huq, F., 2000. From arms-length to collaborative relationships in the supply chain: An evolutionary process. International Journal of Physical Distribution & Logistics Management 30, 750–764. doi:10.1108/09600030010351453

Isaksen, A., 2003. "Lock-in"of Regional Clusters: The Case of Offshore Engineering in the Oslo Region., in: Cooperation, Networks, and Institutions in Regional Innovation Systems. p. 247.

Jaffe, A.B., Trajtenberg, M., Fogarty, M.S., 2000. Knowledge spillovers and patent citations: Evidence from a survey of inventors. NBER/Sloan~ 21.

Kamath, R.R., Liker, J.K., 1994. A Second Look at Japanese Product Development. Harvard Business Review 72, 154–170.

LaBahn, D.W., Krapfel, R., 2000. Early supplier involvement in customer new product development: a contingency model of component supplier intentions. Journal of Business Research 47, 173–190.

Liker, J.K., Kamath, R.R., Nazli Wasti, S., Nagamachi, M., 1996. Supplier involvement in automotive component design: are there really large US Japan differences? Research Policy 25, 59–89. doi:10.1016/0048-7333(95)00826-8

Martinsuo, M., Ahola, T., 2010. Supplier integration in complex delivery projects: Comparison between different buyer–supplier relationships. International Journal of Project Management 28, 107–116. doi:10.1016/j.ijproman.2009.09.004

McGinnis, M.A., Vallopra, R.M., 1999. Purchasing and Supplier Involvement: Issues and Insights Regarding New Product Success. Journal of Supply Chain Management 35, 4–15. doi:10.1111/j.1745-493X.1999.tb00057.x

McKenna, M., Wilczynski, H., VanderSchee, D., 2006. Booz & Company: Capital Project Execution in the Oil and Gas Industry: Increased Challenges, Increased Opportunities.

Mikkola, J.H., Skjoett-Larsen, T., 2003. Early supplier involvement: implications for new product development outsourcing and supplier-buyer interdependence. Global Journal of Flexible Systems Management 4, 31–41.

Mikkola, J.H., Skjøtt-Larsen, T., 2006. Platform management: Implication for new product development and supply chain management. European Business Review 18, 214–230. doi:10.1108/09555340610663737

Mowery, D.C., Oxley, J.E., Silverman, B.S., 1996. Strategic alliances and interfirm knowledge transfer: Strategic Alliances and Interfirm Knowledge Transfer. Strategic Management Journal 17, 77–91. doi:10.1002/smj.4250171108

Norwegian Petroleum Directorate, 2013. Evaluation of projects implemented on the Norwegian shelf.

Olsen, B.E., Haugland, S.A., Karlsen, E., Johan Husøy, G., 2005. Governance of complex procurements in the oil and gas industry. Journal of Purchasing and Supply Management 11, 1–13. doi:10.1016/j.pursup.2005.03.003

Petersen, K.J., Handfield, R.B., Ragatz, G.L., 2005. Supplier integration into new product development: coordinating product, process and supply chain design. Journal of Operations Management 23, 371–388. doi:10.1016/j.jom.2004.07.009

Porter, M.E., 1998. Competitive advantage: creating and sustaining superior performance.

Prahalad, C.K., Hamel, G., 1990. The core competence of the corporation. Boston (MA) 235–256.

Quinn, J.B., Hilmer, F.G., 1994. Strategic Outsourcing. Sloan Management Review 35(4), 43–55.

Ragatz, G.L., Handfield, R.B., Petersen, K.J., 2002. Benefits associated with supplier integration into new product development under conditions of technology uncertainty. Journal of Business Research, Marketing Productivity 55, 389–400. doi:10.1016/S0148-2963(00)00158-2

Ragatz, G.L., Handfield, R.B., Scannell, T.V., 1997. Success factors for integrating suppliers into new product development. Journal of product innovation management 14, 190–202.

Rosell, D.T., Lakemond, N., 2012. Collaborative innovation with suppliers: a conceptual model for characterising supplier contributions to NPD. International Journal of Technology Intelligence and Planning 8, 197. doi:10.1504/IJTIP.2012.048477

Ruuska, I., Ahola, T., Martinsuo, M., Westerholm, T., 2013. Supplier capabilities in large shipbuilding projects. International Journal of Project Management 31, 542–553. doi:10.1016/j.ijproman.2012.09.017

Sasson, A., Blomgren, A., 2011. Knowledge Based Oil and Gas Industry.

Spekman, R.E., 1988. Strategic supplier selection: Understanding long-term buyer relationships. Business Horizons 31, 75–81. doi:10.1016/0007-6813(88)90072-9

Strauss, A., Corbin, J.M., 1990. Basics of qualitative research: Grounded theory procedures and techniques. Sage Publications, Inc, Thousand Oaks, CA, US.

Tan, K.C., 2001. A framework of supply chain management literature. European Journal of Purchasing & Supply Management 7, 39–48. doi:10.1016/S0969-7012(00)00020-4

Teece, D.J., 1998. Capturing value from knowledge assets. California management review 40, 55–79.

d

Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic capabilities and strategic management. Strat. Mgmt. J. 18, 509–533. doi:10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

U.S. Energy Information Administration, 2014. Information on oil and gas ressources - Norway.

Wynstra, F., Van Echtelt, F., 2001. Managing supplier integration into product development: A literature review and conceptual model, in: The 17th Industrial Marketing Purchasing Conference.

Wasti, S.N., Liker, J.K., 1997. Risky Business or Competitive Power? Supplier Involvement in Japanese Product Design. Journal of Product Innovation Management 14, 337–355. doi:10.1111/1540-5885.1450337

Wynstra, F., van Weele, A., Weggemann, M., 2001. Managing supplier involvement in product development: Three critical issues. European Management Journal 19, 157–167. doi:10.1016/S0263-2373(00)00090-6

Appendix A: Interview guide for supplier participants

Part 1 General:

- Please tell me about your job and your tasks in field development projects?
- Is your company engaged in relationships to customers and what are the relationships like? (close, long-term or irregular and arm's length?)
- How does collaboration with your customer emerge at your company?
- Does your company have frame-agreement contracts or is specific one-time contracting more common?

Part 2 Specific:

Concept:

- Supplier Integration is meant as a form of collaboration where the buying company acts as a system integrator and the suppliers bring in their specific know-how in purpose of executing a project together
    - The main idea is that every company has specific core competencies and capabilities and it is therefore necessary to integrate different suppliers in the project to execute it
    - The responsibility can be from advising only with design ideas to be fully responsible for the design of parts of the project
- ESI is used as a concept where project members of a key-supplier become part of a cross-functional project-team to contribute from the beginning of the project, especially in the technical assessment and the planning of the project in the front-end phase
    - Specific supplier-knowledge can be used in feasibility studies of the project, in the technical design of the project and the planning phase of the project
    - Suppliers become involved so early for 3 reasons:
        - 1. To examine and solve a technological problem trough their specific knowledge
        - 2. To make the project more efficiently, to make it right the first time
        - 3. To create a better technical solution as the buying company could do itself
    - To enable ESI the participating companies regularly have a long-term relationship to align the processes and build trust over time

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- Have you or your company experienced collaboration in form of supplier integration in your customer's projects?
- Have you experienced collaboration in form of early involvement as I described it?
- I want you to think of a specific project, a specific collaboration with a buyer in the recent time, where you were involved early, please tell me about it?
- Can you tell me about the project and your experience on being involved early?
- Have you collaborated with this customer before?
- How is the inter-firm relationship?
- Where you integrated in your customers project team?
- What was the degree of responsibility on solution design in this collaboration?
- What was your company's main contribution to this project?
- What do you think was the main reason for involving you early?
- Have you experienced differences in contributing your firm's knowledge and know-how to the project to other forms of collaboration?

Part 3:

- What do you think in general is the main advantage of involving you as a supplier early in the project?
- Do you think that your firm's specific knowledge and know-how is used more effectively or efficiently when involving you early in the project and integrating you in the project team?
- What do you think will be the future development of buyer-supplier collaboration?

Thank you for your time!

Appendix B: Interview guide for operator participants

Part 1 General:

- Please tell me about your professional background?
- What is your role in field development projects and where do you have contact to buyer-supplier collaboration?
- Is your company engaged in relationships to suppliers and what is this relationship like? (long-term or arm's length?)
- How many high-involvement relationship-suppliers does your company have?
- Does your firm cooperate often with suppliers or how would you describe the way your company makes business with its suppliers?
- How does cooperation with your suppliers emerge at your company?
- How important is supplier assessment for your company?
- Would you engage with suppliers without previous experience and supplier assessment if this supplier would deliver key-technology?
- Does your company use frame-agreement contracts or is specific one-time contracting more common?
- Do you purposely separate between your suppliers in treatment and relationship?
- Does your company actively search for supplier collaboration to develop solutions to new and unsolved problems?

Part 2 Specific:

- Supplier Involvement is meant as a form of collaboration where the buying company acts as a system integrator and the suppliers bring in their specific know-how in purpose of executing a project together
    - The main idea is that every company has specific core competencies and capabilities and it is therefore necessary to integrate different suppliers in the project to execute it
    - The responsibility can be from advising with design ideas to be fully responsible for the design of parts of the project
- ESI is used as a concept where project members of a key-supplier become part of a cross-functional project-team to contribute from the beginning of the project, especially in the technical assessment and the planning in the front-end phase of the project

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- Specific supplier-knowledge can be used in feasibility studies of the project, in the technical design of the project and the planning phase of the project
- Suppliers become involved so early for 3 reasons:
  - 1. To examine and solve a technological problem with their specific knowledge
  - 2. To make the project more efficiently, to make it right the first time
  - 3. To create a better technical solution as the buying company could do itself
- To enable ESI the participating companies regularly have a long-term relationship to align the processes and build trust over time

- The interest for my study is mainly, how early involvement of a supplier affects his contribution to the technologic solution of the operator's development project?
- Is this concept familiar to you?
- Have you or your company experienced collaboration with supplier in form of ESI in your projects?
- I want to ask you to think of a specific project, a specific collaboration with a supplier in the recent time, where a supplier was involved early
- Can you tell me about the project and your experience of suppliers being involved early?
- Have you collaborated with this supplier before?
- How is the inter-firm relationship with this supplier?
- Was/Is the supplier integrated in your project team?
- What was/is the degree of responsibility of the supplier on solution design in this collaboration?
- What was the supplier's main contribution to this project?
- What was the main reason for involving the supplier early?
- Have you experienced differences in the use of supplier's knowledge and know-how to the project to other forms of co-operation?

Part 3:

- What do you think in general is the main advantage of integrating a supplier in the project team?

- What do you think in general is the main advantage of involving a supplier early in the project?
- Do you think that supplier's specific knowledge and know-how is used more effectively or efficiently when involving him early in the project and integrating him in the project team?
- What do you think about the interdependency arising from close collaboration in ESI? Should it be avoided or is it positive?
- What do you think will be the future development of buyer-supplier collaboration?

Thank you for your time!

Curriculum Vitae

PERSONAL DETAILS

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EDUCATION

Apr. 2014 – Sep. 2014	Master's Thesis in Project Management, Faculty of Social Science and Technology Management - Norwegian University of Science and Technology Trondheim (Norway)
Mar. 2013 – approx. Oct. 2014	Master of Sciences in Business Administration and Engineering - Technical University Dortmund, Dortmund (Germany)
Oct. 2010 - Feb. 2013	Bachelor of Science in Business Administration and Engineering (Industrial Engineering) - University of applied sciences Darmstadt, Darmstadt (Germany)
Oct. 2007 - Oct. 2010	Studies in mechanical engineering - TU Darmstadt, Darmstadt (Germany)
Jun. 2006	Abitur (Certificate of General University Maturity) - Landschulheim Steinmühle, Marburg/Lahn (Germany)

PROFESSIONAL EXPERIENCE

Jun. 2013 - Mar. 2014	Part-time job project management – First Data GmbH, Bad Vilbel (Germany): Design and implementation of weekly, monthly and yearly performance- and management reports of various projects and project resources; support of the project management team in their planning and controlling tasks
Aug. - Oct. 2012	Bachelor's thesis - 100 % renewable Foundation (JUWI Holding AG), Berlin (Germany): Topic: „Strategic positioning and derived funding of a NPO on the example of the 100% renewable Foundation"
Nov. 2011 - May 2012	Internship Key-Account-Management/Sales - Jettainer GmbH (Lufthansa AG), Raunheim (Germany): Design and implementation of weekly, monthly and yearly performance- and management reports, design and execution of a customer segmentation for upcoming sales activities, design and realization of a customer satisfaction survey, supporting Key-Account-Managers in customer service of existing customers (especially Etihad Airways and Swiss Airways) and in the integration process of new customers, support of a management consultancy in an internal strategy process for Jettainers future strategy, support in the implementation of workshops, mailings and fair preparation

Sep. - Oct. 2010	Student job - search engine optimization - Hoppenstedt Publishing, Darmstadt (Germany): Coordination and implementation of a review of the information offered on the website through CMS, integration of technical articles through CMS
Nov. 2007 - Apr. 2009	Working student - Engineering Office Prof. Pfeifer und Partner, Darmstadt (Germany): Support of the engineering department in projects, independent execution of smaller projects (design of components, etc.), support of the sales department (proposals, response to public tender)
Jun. - Aug. 2007	Internship mechanical engineering and business administration - Elkamet Kunststofftechnik, Biedenkopf (Germany): Fundamentals of metal machining and CAD-development, experience in sales, logistics and controlling
Sep. 2006 - May 2007	Social service (Zivildienst) as a nurse on ward in neurology - university hospital of Marburg, Marburg/Lahn (Germany): Patient care, nursing anamnesis, monitoring of vital signs, patient's primary care

ADDITIONAL EXPERIENCE

May - Jul. 2011	Project: "KPIs and reporting systems in the project- and process controlling"; elaboration on "Project Program- and Project Portfolio Reporting"
Oct. - Dec. 2010	Participation in case study exercises at the Department of Logistics, "Planning and control of enterprise-internal logistic processes"; application of Witness 2010 (Lanner Group)
Aug. - Oct. 2004	Language exchange to Wesley College - Melbourne (Australia)

LANGUAGE SKILLS

- German - native speaker
- English - fluent (TELC level-B2 business english)
- French – basic
- Spanish - basic

COMPUTING SKILLS

- Highly competent user of Microsoft Office, especially Excel, Powerpoint and Outlook
- Competent user of Microsoft Project

September 2014,

Lukas Wagner