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A Study of Major Projects and Contractual conditions:
A Framework for Performance Improvement

Master thesis

by

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Acknowledgements

This Master's Thesis finalizes a Master's Degree in Industrial Economics completed at the University of Stavanger. The two years of education program have given me more insight and knowledge of the industry in general, with emphasis on the Petroleum sector. I believe this will become useful in my future career.

I would like to thank my supervisor Professor Jayantha Prasanna Liyanage for his support and help given throughout the work of this thesis. His competency and experience have helped me on the right track when I have faced difficulties.

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Summary

The oil price has experienced a significant decline since the second half of 2014. In combination with the high cost level, many field developments in the Norwegian petroleum sector entail marginable profit. As a counter measure to cope with the challenging market conditions, both oil companies and service suppliers are making various efforts such as substantial downsizing internal staff, as well as reducing costs in all phases of the project. Moreover, major players have increasingly explored the possibilities that lie in collaborative and mutually beneficial relationships. As the market condition and oil price are expected to remain volatile, oil- and service supplier companies are now searching for strengthened competitive positioning through contractual innovation that can drive and sustain performance and efficiency. Gaining stability and control over cost development in projects is crucial for staying competitive in the business.

The thesis studies a few major development projects across two industry sectors, evaluating various options for strengthening the competitive positioning for oil- and supplier companies, and ultimately presenting a framework for performance improvement.

The study of projects points out common pitfalls and highlight important lessons from the projects. Key lessons are addressed to project planning, contract strategy, compliance of Norwegian requirements and the interaction between operator and contractor organization. On the basis of study findings and current market conditions, three options for strengthening the competitive positioning for Norwegian players are evaluated. (1) Formation of strategic alliance, (2) Risk-gain sharing agreements and performance based contracting and (3) Waste reduction to go 'lean'. The study suggests option (2) and (3) can be more facilitated in the environment of a strategic alliance. Therefore, the thesis presents a framework for performance improvement, focusing on the benefits and challenges, values and risks associated with the formation of a strategic alliance. The thesis argues that with the modern market conditions, alliances are a viable option that can entail benefits such as strengthened & shared capabilities, stimulation of innovative technology development, and

integrated capacity that supports growth for effectivity & efficiency. The study also revealed common challenges and pit falls such as cultural gaps, integration failure and worker resistance. However, if done right, the framework suggest the collaboration model can unlock significant value and mutual benefits for the partners, an approach more suited for addressing the financial and competitive challenges arising in today’s oil and gas industry with low- oil price and margins.

It is suggested that the challenges associated with strategic alliances can be alleviated by introducing industrial clusters devoted for strategic alliances. Removing the regional boundaries traditionally observed in clusters, and introducing real-time communication between strategic alliances on a global level can provide growth for better experience flow, opportunities to improve and more successful alliance relationships. A suggestion for future study is connecting with companies within a strategic alliance in order to access contract details so that a further specified framework can be developed.

Table of Contents

Acknowledgements... III

Summary...IV

List of Figures...IX

List of Tables...X

Nomenclature...XI

1 Introduction 1

1.1 Background 1

1.2 Statement of problem 2

1.3 Scope and objective... 3

1.4 Methodology 3

1.5 Limitations of the study... 3

1.6 Structure of the work... 4

2 Literature review 5

2.1 Project management 5

2.1.1 Understanding the project triangle... 5

2.1.2 Monitoring and control 6

2.2 Contract theory... 7

2.3 Contract strategy 8

2.4 Incentive theory... 10

2.5 Compensation format 11

2.5.1 Fixed-price 12

2.5.2 Rates and norms... 12

2.5.3 Cost-reimbursable... 13

2.5.4 Incentive... 13

2.6 Asymmetric information 15

2.7 Variation order / Change order 15
3 Oil & gas industry 17
3.1 Implementation process on the NCS 17
3.2 Project life cycle & risk management 18
3.3 Responsibility and ownership 20
3.4 Cost development 21
3.4.1 Norwegian Continental Shelf 21
3.4.2 International 22
4 Contract structure on the NCS 24
4.1 Separated vs larger contracts 24
4.1.1 Risk tradeoff 28
4.2 NORSOK 28
4.3 Standardized contracts 29
4.4 History of Norwegian total contracts 29
5 Study of major development projects 31
5.1 Yme 32
5.1.1 Field description, history & redevelopment 32
5.1.2 Cost development 34
5.1.3 Project experience 35
5.1.4 Lessons learned 38
5.1.5 Reflection 39
5.2 Goliat 41
5.2.1 Field description & history 41
5.2.2 Cost development 43
5.2.3 Project experience 44
5.2.4 Reflection 45
5.3 Valhall redevelopment 47
5.3.1 Field description, history & re-development 47
5.3.2 Project experience & cost development 48

5.3.3 Reflection 50
5.4 E6 Langslett-Sørkjosen 51
5.4.1 Project description & history 51
5.4.2 Project experience 53
5.4.3 Lessons learned 55
5.4.4 Reflection 55
5.5 Summary of study – brief overview 57
5.6 Summary of study - detailed overview 59
6 Recommendation 62
6.1 General lessons learned 62
6.2 Strategic options for performance improvement 64
6.3 General/common performance variables related to Contracts 69
6.4 Attributes/Critical features of performance improvement under Contractual conditions 71
6.5 Selected strategic approach 73
6.5.1 Strategic alliance 73
6.5.2 Performance improvement framework 75
6.5.3 Some selected challenging attributes for performance improvement 78
6.5.4 Benefits 86
6.5.5 Challenges & success factors 88
6.6 Addressing common challenges 90
7 Discussion 92
7.1 Lessons learned 92
7.2 Further Development of Strategic Alliances 93
7.3 Future study 93
7.4 Challenges 93
8 Conclusion 94
9 References 95

List of Figures

Figure 2.1 The scope triangle [7]. 5
Figure 2.2 Framework for alternative contract strategies. Figure modified from [4]. 10
Figure 2.3 The illustration shows how operator and contractor in incentive contracts share potential losses or profit. Figure modified from [12]. 14
Figure 4.1 Main activities included in contracts for offshore projects [8]. 24
Figure 4.2 Separate (traditional) contract structure 25
Figure 4.3 Larger contracts with one main supplier 26
Figure 4.4 The probability distribution of development costs associated with traditional tender contracts (g(K)) vs EPC-contracts (f(K)). Figure modified from [4]. 27
Figure 5.1 Licensee's share of project Yme [8.] 32
Figure 5.2 Historic timeline of project Yme [19] 34
Figure 5.4 Location of the Goliat Field outside Hammerfest [20]. 41
Figure 5.5 Goliat contract strategy in development & technology area. Modified and based on [21]. 42
Figure 5.6 Licensees' share of project Valhall Redevelopment [8]. 47
Figure 5.8 The red line illustrates the location for the planned tunnel [25]. 51
Figure 6.1 General/common performance variables in a project 69
Figure 6.2 Illustrates network effectiveness based on Partnership health, Capability matching and Objective alignment [44]. 76
Figure 6.3 Success factors for Strategic alliances, modified and based on [41]. 89

List of Tables

Table 3.1 Major development projects on the NCS [8]. 22
Table 5.1 Planned and actual cost development for the Yme project [8]. 35
Table 5.2 Licensees share of project Goliat 41
Table 5.3 Planned and realized cost development for project Valhall redevelopment [8]. 50
Table 5.4 Recommendation for project approach 52
Table 5.5 Comparison of studied projects 57
Table 5.6 Detailed comparison of studied projects 59
Table 6.1 Advantages and disadvantages of various strategic options 68
Table 6.2 Attributes/Critical features of performance improvement under Contractual conditions [17]. 71
Table 6.3 Definitions of network conditions [44]. 75
Table 6.4 Categorization of attributes for performance improvement [17]. 77
Table 6.5 Identified key benefits of strategic alliance [41]. 87

Nomenclature

BP = British Petroleum

CIAM = Collaborative Cluster on Industrial Asset Management

EEA = European Economic Area

EPCIC = Engineering, Procurement, Construction, Installation, Commissioning

EY = Ernst & Young

E&P = Exploration and Production

FEED = Front End Engineering Design

FPSO = Floating Production Storage and Offloading

HSE = Health, Safety and Environment

HHI = Hyundai Heavy Industries

IPA = Independent Project Analysis

MOPU = Mobile Offshore Production Unit

MPE = Ministry of Petroleum and Energy

NCS = Norwegian Continental Shelf

NF = Norwegian Fabrication contract

NTK = Norwegian Total Contract

NTK MOD = Norwegian Total Contract Modification

NPD = Norwegian Petroleum Directorate

NPRA = Norwegian Public Roads Administration

O&G = Oil and gas

OSSA = Obras Subterraneas

OFS = Oilfield service

PDO = Plan for Development and Operation

PBC = Performance Based Contracts

PSA = Petroleum Safety Authority Norway

IPA = Independent Project Analysis

SBM = Single Buoy Moorings

TBL = Teknologibedriftenes linjeforening

1 Introduction

1.1 Background

Investments in the Norwegian petroleum sector have the last years skyrocketed due to high demands and high oil & gas prices the last decade. The high activity level the past years has therefore resulted in higher investment- and operating costs. The cost level on the Norwegian Continental Shelf (NCS) has increased way beyond the domestic inflation rate. The cost of constructing a new platform has increased by 150% since 2000. In other words, with the same amount of money, you get “2.5 times less platform” in 2013 [1,2].

Simultaneously, the productivity in the oil & gas industry has dropped 74% in the last two decades, while the efficiency in the industry in total has increased 29%. The key trends affecting efficiency loss are more regulation, greater complexity and enlarged growth focus [1].

The high cost level incentivized Norwegian oil companies in late 2000s to look abroad for acquiring cheap labor. Substantial resources of labor is typically required in the implementation phase of a project, and foreign contractors seemed willing to manage large EPC-contracts (Engineering, procurement, construction) and the risk that followed. It appeared very attractive as it was cheap, transferred majority of the risk to the contractor and in this way required less follow-up from the operator’s side. However, experience show they were associated with greater uncertainty that often resulted in delay in schedule and low quality, ultimately leading to substantial cost overruns.

The easiest accessible resources of oil & gas (O&G) have already been depleted, making new field developments more complex due to greater technical, financial and environmental risks that follows deep water and remote developments. Simultaneously, cost inflation, taxes, governmental intervention and scarcity of resources have had an amplifying effect, further shifting value away from oil- and supplier companies. The altered environment have significantly pressurized the traditional contract regime. Oil- and service supplier companies are now desperately seeking strengthened competitive positioning through contractual innovation that can drive performance, efficiency and provide more stability [41].

1.2 Statement of problem

Norwegian magazine *Teknisk ukeblad* revealed in an article from 2015 that projects cost overruns on the Norwegian Continental Shelf (NCS) has exceeded NOK 200 billion's since 2002, after analyzing company budgets [3]. The problem is not only a concern for the companies involved, but also for the government. Under Norwegian law, oil companies can deduct 78% of their costs from their taxes. In other words, outrageous sums which will be charged on the community (taxpayers).

Norwegian Petroleum Directorate (NPD) conducted in 2013 a report on the subject, studying major development projects and concluded the following main factors for delay and cost overrun, *early phase planning, pre-qualification of suppliers, contract strategy & project follow-up* [8]. Besides putting the majority of blame on operators, the reports gave few direct implications on *how* to prevent overruns in future implementations.

The oil price has drastically declined since the second half of 2014. In combination with the high cost level, many field developments in the Norwegian petroleum sector entail marginal profits. The industry needs to develop new ways of thinking in order to stay competitive. It is essential to find intelligent cost cuttings and improvements within contracting and operational performance. Moreover, the majority of spend in oil and gas contracts are structured in ways that do not compensate suppliers based on performance.

As a counter to tackle the tight market conditions, both oil- and supplier companies are excessively downsizing staff, as well as making various efforts to reduce development costs in all phases of the project. Moreover, major players have explored the possibilities than lie in collaborative and mutually beneficial relationships.

As the market condition and oil price is expected to remain volatile, gaining control over cost development in projects is crucial for staying competitive in the business.

1.3 Scope and objective

The purpose of this thesis is to study a few major development projects across two industry sectors, highlight important lessons and suggest a framework for performance improvement, presenting the impacts in values and risks associated with Strategic Alliances.

1.4 Methodology

This thesis will primarily use qualitative methods and study projects based on document analysis of literature, papers and news from recognized magazines. Four development projects across two industry sectors will be studied in order to point out common pit falls and extract lessons learned. The study will try to explore new opportunities and give recommendations for performance improvement within the traditional contract regime.

Relevant information and expert opinions was received from the Collaborative Competence Cluster on Industrial Asset Management (CIAM) at the University of Stavanger. The writer participated in a meeting with a knowledge based HUB called "Asset Economy and Cost Engineering", and received access to documents and notes from past meetings.

The thesis utilize data and information that is publicly available and not deemed confidential, with the exception of few documents and notes from previous HUB meetings.

1.5 Limitations of the study

The four studied projects are limited to a manageable, but representative selection. There was no specific company involved in the process of writing this thesis. Data was collected from public cases and available information, except few documents and notes from the Hub. The study is based on general trends and general observations.

1.6 Structure of the work

This thesis is presented in eight chapters.

- Chapter 1 presents the background for the study, describes the problem, objective, methodology and limitations for the study
- Chapter 2 presents a review of relevant literature for the thesis
- Chapter 3 gives an overview of the oil & gas industry
- Chapter 4 introduces the historical contract structures on the NCS
- Chapter 5 presents a study of major development projects
- Chapter 6 includes recommendations to project implementations and presents a framework for performance improvement contracts
- Chapter 7 discusses important lessons learned, challenges associated with the study, future development for strategic alliances and the suggested areas for future study
- Chapter 8 presents the conclusion for the thesis

2 Literature review

2.1 Project management

A project is defined as a sequence of unique, complex and connected activities that have one goal or purpose to be completed within a specific time, within budget and according to certain specifications. Projects are dynamic systems that must be kept in equilibrium. Figure 2.1 illustrates a scope triangle, which explains the dynamics in a project.

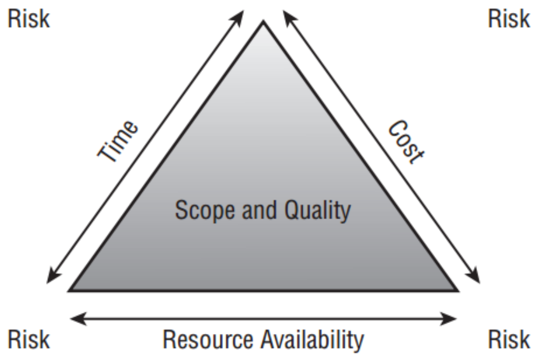

Figure 2.1 The scope triangle [7].

2.1.1 Understanding the project triangle

The triangle represents five constraints that operate in every project. These parameters are key factors for a successful project. The constraints are dependent of each other, meaning that and a change in one will cause at least one other variable to change to maintain equilibrium (balance) of the project. Affection of either sides in the triangle will also affect the scope or quality, but also the opposing side. For example, a cost reduction in the project will require more time in order to maintain the same level of quality. This might cause delay relative to the estimated project time.

The constraints that operate in every project are

- Scope
- Quality

- Cost
- Time
- Available resources

The scope of the project defines the boundaries of the project, what is included and excluded from the project. The scope can be referred to as a document of understanding, and is meant to be the foundation for all subsequent project work.

Quality within a project distinguishes between product quality and process quality. It can be useful to invest in a quality management program to monitor the work in a project. This will support customer satisfaction and help organizing resources more efficiently. The cost of the project in another important variable and is often defined as the budget established for the project. Cost must be considered throughout the project management life cycle.

A project will always have a timeframe or deadline for the date of completion. One will observe that time and cost are typically inversely related to each other. A project can be completed faster if they spend more money. Project management involves allocating time in the most effective and productive way possible. The resources within a project are assets such as employees, equipment, inventory and physical facilities, all of which have limited availabilities. These can be fixed or variable resources and are central for organizing project activities and finishing on time. Risk does not actively affect the management of the five other constraints, but it is always present and influences internal and external parts of the project.

2.1.2 Monitoring and control

It is the project manager's responsibility to be well informed of the project scope and know which solutions to apply at all times. A project plan is dynamic and will change throughout the project life cycle. A complete plan must therefore establish clear tasks, why the tasks are necessary, who is assigned the specific tasks, when is the expected completion date, what resources are needed and what criteria must be met for the project to be declared complete and successful.

A well planned project reduces uncertainty elements because the various outcomes are already accounted for. Thorough planning provides better understanding of the projects objectives, and improves efficiency by monitoring which resources are available at what times. This will facilitate working with several processes in parallel, which can shorten completion time. Any changes in the project during execution phase can have major consequences and can result in delays and cost overruns. Therefore, it is crucial to have a satisfactory system for monitoring and control. This is essential for determining whether the project can be executed according to plan and budget, and if not, initiate the necessary measures to get the project back on track as soon as possible.

Project follow-up is a major part of ensuring monitoring and control, and involves that the project manager continuously receive reports with details of what has happened in the project up to certain milestones and up to date. This serves the purpose of early detecting deviations and fluctuations between planned and measured results, and addressing it with appropriate measures. Monitoring and controlling the project is the core of project management and require correct actions when deviations occur. It is important that each deviation is analyzed before determining how to approach, and how to communicate the solution in a clear manner [7].

2.2 Contract theory

Traditional contract theory refer to the operator as *principal* and contractor as *agent*. The principal delegates a specified assignment to an agent, who delivers a product or service. The principal thereafter supervises the agents work, but does not participate actively. Central points within contract strategy is incentive theory, risk allocation and compensation agreement [4].

Every project is unique, and therefore each contract must be customized to the situation. There are two main basis for consideration when selecting a contract strategy.

- ❖ The characteristics of the transaction
- ❖ The characteristics of the principal and agent

The first basis for consideration is the characteristics of the transaction. This involves the degree of complexity, and whether there is repetition from past projects. Resemblance to previous projects will provide prediction and decrease the risk of unexpected events occurring. How the project information is allocated and shared between the parts is also important. Furthermore, the degree of how specified the project is in details, and the expected amount of project changes are important factors to consider when choosing contract strategy.

The second basis for consideration accounts for the characteristics of the parties involved. Central elements are the power distribution (equality or imbalance) between the operator and contractor, their financial strengths and their ability and willingness to take on risk. In the petroleum industry, operators normally carry higher financial strength and carries the most risk. Finally, the trust and reliability between the parts affects the contract strategy greatly because it determines how formal or unformal the contract is [5].

2.3 Contract strategy

Contract strategies can be characterized along two dimensions:

- The degree of integration between the players, and
- The degree of congruence between the players

The degree of integration between the players

The extent of integration between the players can be defined in contractual terms as conventional, alliance or relational.

Conventional contracts are the classic, jurisdictional detailed contracts. In these contracts, the players work separately and distantly. These contracts use incentives and flat rates/fixed price. Alliance contracts is a contract type where the players cooperate closely and have shared responsibility for project implementation. These contracts are built on mutual trust and loyalty. Trust and loyalty helps settling ambiguous contractual details and supports achieving common goals and philosophy. It has also proved to improve the relationship between the players and reduce the risk of conflicts. Long-term rewards in such agreements are opportunities for further collaboration. More advantages are increased communication, flexibility and experience. Relational contracts are a mix of conventional and alliance, which represents frequent interaction between the (independent) players, but also preserves the formal responsibilities in the contract. The interaction between the players also involve implied contractual elements based on mutual trust and loyalty.

The degree of congruence between the players

Congruence describes by how far the agent follows the principal's interest to maximize the value of the project and minimize the costs. A distinction is made from the lowest to highest order; wanting to minimize costs in each contract, minimize project investment, minimize the project life-cycle costs and maximizing the project's life cycle value.

1. Order

It is natural for subcontractors to minimize the costs in each contract, as each contract is observed isolated. It is therefore difficult to see the project in its entirety with regard to coordination. In such low-order incentives, with fixed price, the supplier will primarily reduce own costs and produce as cheap as possible, as opposed to the principal who wants high quality and low cost.

2. Order

Minimizing the project's investment is the next step where a sub-supplier see multiple deliveries in context. The goal is to coordinate so that progress adds up to the best interests of the whole project financially.

3. Order

Minimizing the projects life cycle costs is the third step, which not only considers the investment cost, but also takes into account operating costs, maintenance costs and removal costs. This will provide savings in the long run for the principal and also increase present value. This is especially important in the petroleum industry.

4. Order

Maximizing the projects life cycle is the optimal extent of incentives in which the agent and principal share objectives/goals. Maximizing the projects life cycle requires accounting for income, application flexibility and modern technology. Reaching high level of incentive order is challenging without giving ownership to the project.

Figure 2.2 show the different contract strategies can be defined in the degree of integration between the players (horizontal) and the order of congruence between the players (vertical)

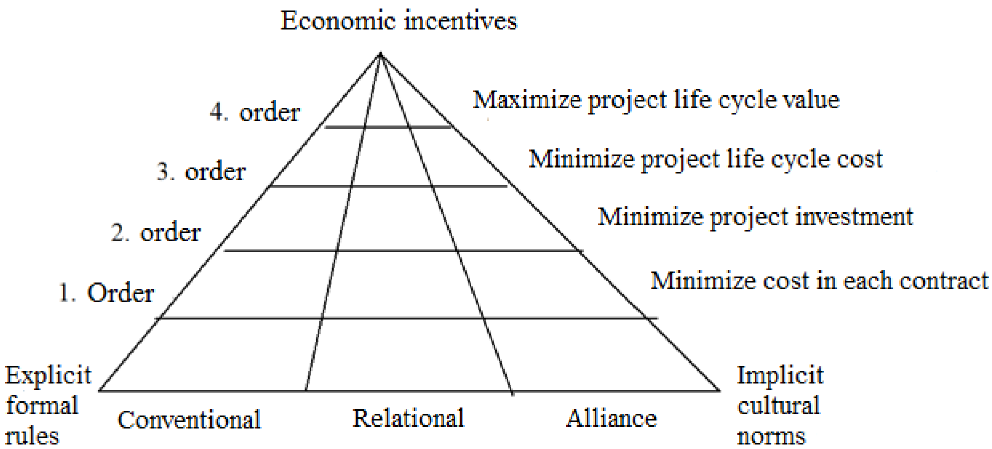

Figure 2.2 Framework for alternative contract strategies. Figure modified from [4].

2.4 Incentive theory

Incentives are used to achieve higher level of congruence between the principal and agent.

In other word, incentives are a motivation the principal gives the contractor so that the parts in an increasingly extent share interest and goals. This is highly necessary in markets where there is a lot of asymmetric information between the parts, which is especially observed in the oil and gas industry. In contracts where high level of congruence is achieved, the parts are also protected from opportunism. Opportunism is when one part takes advantages of the circumstances without regard to the consequences for the other part [4].

Adverse selection is private information that exist before contract signing. This is a matter one cannot control for the part who wants the service completed. Careful research and good assessment before contract signing is very important to avoid adverse selection.

Moral hazard is private information acquired after the contract signing. This is an incentive problem and occurs when there is a conflict of interests between the parts, actions that are not observable occurs, non-verifiable actions and uncertainty is present. It is therefore important that incentives are formed in a way which makes the agent responsible for parts only himself can affect. This must include measureable content that can be easily controlled and verified. This is something the operator must be aware of before selecting the compensation format and contract strategy. Incentives can often lead to uncertainty and it is therefore important that the agent in addition have a risk premium, which with the incentives will create the total compensation.

2.5 Compensation format

The intention of compensation agreements is to distribute risk between the operator and supplier in a fair and cost effective way. The goal is not to eliminate risk, but to select the compensation format that gives the best balance.

Contract theory specifies that the contractor's compensation must be tailored to the specific situation. Field developments on the NCS are comprehensive and varied, and in large contracts, an agreement can often consist of several types of compensation formats designed by the principal and agent. Therefore, some contracts may include specified incentives on some aspects, and fixed-prices on other.

The three most frequently used compensation formats on the Norwegian Shelf is Fixed price, rates & norms, and cost-reimbursable. Incentive contracts is another format but is not represented in the petroleum industry to the same extent. The characteristics of the compensation formats are widely different and reflects contrasting strategies [4].

2.5.1 Fixed-price

The fixed-price is a contractual compensation format whereby the contractor commits to deliver a project to a predetermined cost and quality. The price and quality is negotiated after a tendering process. The contract format holds no benefits if contractors achieve higher quality standards, but penalties applies if the quality is below the agreed standard. It is important that the penalties are big enough to prevent the contractors from opportunism. Because the fixed cost is already determined, the operator can use fewer resources on project follow-up. The format puts a large risk on the contractor since the part is responsible for the final result and must bear all costs in the project implementation. Potential project changes can cause conflicts, re-negotiations and might turn out time-consuming and costly. However, any potential cost savings in implementation of the project will benefit the contractor, as long as it satisfies the agreed quality standard. Because this format is based on a bidding process prior to implementation, calculating an accurate cost estimation is important. Unexpected events can play a crucial role for the production costs. The format suits standardized projects that are predictable and not very complex, where there is a variety of competing contractors. On the contractors side, it is important that the relevant production inputs won’t suffer majorly for potential market shifts [6,8].

2.5.2 Rates and norms

This format is the most common compensation agreement on the Norwegian Shelf. The rates and norms are determined after negotiation and used for calculating the project costs.

Examples are daily rates or unit rates (NOK/ton), which is frequently used in field developments. The operator is responsible for the scope of the project and the risk associated with changes and developments. The contractor takes on the risk related to efficiency and productivity and is responsible for the rates and norms specified in the contract [8].

2.5.3 Cost-reimbursable

In cost-reimbursable contracts, the principal agrees to reimburse all (documented) work hours, production costs and pay a fee for supervising the project. With this type of compensation agreement, the contractor is fully insured and therefore no consequences in case of discrepancies between estimated and actual production cost. The operator therefore takes on all risk associated with productivity and scope of work. A disadvantage is that the contract gives no incentives to initiate cost-reducing efforts [6, 8].

Reimbursable contracts will provide weaker cost incentives compared to fixed-price, a more uncertain cost estimation and will require more resources for follow-up of suppliers cost schedules. However, the benefits with cost-reimbursable is that conflicts are reduced and a faster project completion can be achieved. Moreover, the final cost can be lower than a fixed-price contract because supplier does not have to negotiate an inflated-adjusted price in order to cover cost-related risks.

This agreement suits highly unpredictable development projects with high technological complexity. This compensation is relevant when long-term quality is a higher priority to the company than cost minimization. The format suits highly complex projects where the operators prefer little friction during renegotiations and significant exertion of influence during execution [8,36].

2.5.4 Incentive

The incentive contract most used on the NCS is called *målsum*, which consists of principals from fixed-price (optimal incentives) and cost-reimbursable (optimal risk sharing). The operator and supplier share all potential cost overruns or savings compared to a negotiated reference price (benchmark). The benchmark is a calculated “target price”, “target profit” and quality. The contractor is insured by a “ceiling”, meaning that the operator covers cost overruns exceeding a certain point. The agreement reduces the contractor’s risk, but keeps incentives to limit costs. However, once the ceiling is reached, the contract no longer holds incentives for keeping costs down. In the case of significant cost overruns, the contractors might demand renegotiations of the incentive agreement [6]. Figure 2.3 illustrates how the following parts share potential losses or profit.

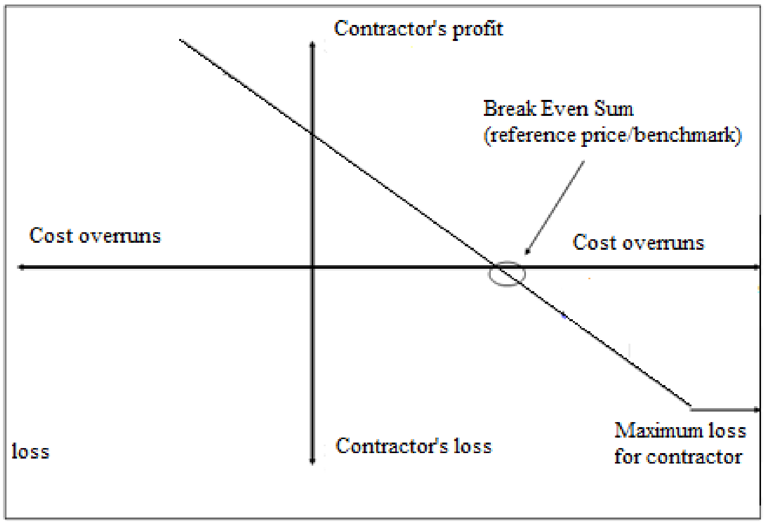

Figure 2.3 The illustration shows how operator and contractor in incentive contracts share potential losses or profit. Figure modified from [12].

However, this contract type is not much used in the O&G industry because the target-prices are difficult to determine. Moreover, conflicts can easily arise because of change orders. This type of format has traditionally not been preferred because of the incomplete designs that follows complex offshore developments.

2.6 Asymmetric information

A major cause of conflicts between operator and contractor is asymmetric information. Another word is strategic reporting, and occurs if either parts (or both) possess information about their own productivity, cost estimation etc. that is not available and free of charge for the other part. Moral hazard (covered behavior) is another form of strategic behavior which occurs when contractor possess private information and use it to his own advantage in the execution of the project. Such activities generally cause problems with regard to strategic behavior in tender processes and monitoring [4].

A specialized contractor will normally have more insight and expertise in the scope of work of a project, and will in some cases be able to predict that a project will be more comprehensive than the customer assumes. A contractor might have the incentive to use strategic pricing to win the contract and later generate profit through change order.

Strategic pricing, or underestimation, was frequently observed in the old fabrication contracts. The special rules of EPC-contracts implies that the issue of underestimation has been limited after the transition to the new contract terms. The petroleum industry is special because it was until late 90s mostly operator who calculated the PDO estimate and handled procurement. It is therefore also possible for the operator to hold back private information about important cost elements.

Well-established relationships between operator and contractor are built on long-term trust, implicit contractual understandings and involves restraining from strategic behavior that can provide short-term earnings.

2.7 Variation order / Change order

In economic contract theory, a complete contract is defined as a contract that regulates the parts obligations in any future situation and which contain penalty fees for breach of contract. A contract as such would include all precise details of any scenario concerning fabrication and economics.

In practice, one cannot foresee all possible changes in the regulatory framework. Creating a contract this comprehensive would also be too costly. Therefore, in practice we enter incomplete contracts. Incomplete contracts are renegotiated along the way, and the distribution of power between the parts can be decisive for the outcome. A good contract will therefore include mechanisms that protect both parties in such renegotiations.

Deliveries to the Norwegian Shelf is known for technical innovations and frequent design changes along the process. Complex transactions occurring over a long time is unpredictable and it is practically impossible to create a contract so detailed that it covers all possible changes in the regulatory framework. It is therefore challenging for contractors to estimate costs. If contractors miscalculate cost estimation in tendering, there is a risk that the contractor may try to argue for significant functionality changes and claim variation to the work, in order to catch up profitability. However, it is also possible that operators also obtain new information that can lead to change orders. The contract terms must therefore include mechanisms for handling and pricing of variation orders.

Field development projects require contractual and organizational forms that clearly divides responsibilities between the parts. Negotiation of variation orders are inevitable, detailed project specification is not available, construction and engineering cost are uncertain, and measurement of performance is difficult. It is for these reasons important that the contract is designed to protect both sides against unnecessary risk and strategic positioning of the other part.

EPC-contracts contains mechanisms specifically designed for handling and pricing of variation orders, and procedures for handling conflicts. However, variations to the work is difficult to measure, and these variables often include asymmetric information. It is therefore a challenge to calculate the actual cost of additional work, especially after fabrication is initiated [4].

3 Oil & gas industry

3.1 Implementation process on the NCS

Norway is a member of the EEA-agreement (European Economic Area) and hence internationally obliged to follow certain rules related to public acquisition. The initiative behind the agreement was to strengthen competitiveness across borders and create an “internal European brand”. The purpose of the acquisition law §1-3 is to create value for the society and maximize the efficiency of resources in public acquisitions based on professionalism and equal treatment. The act applies to acquisition of goods, services and construction work. Basic principles within the agreement are requirements for competition, good business practices, transparency and equal treatment for suppliers. All purchase of goods and service applies to the EEA-agreement. This involves a number of rules for operators and suppliers to follow before all types of acquisition of services and goods to the NCS.

In the acquisition process, the operator announces the need of acquisition for the suppliers. In order to participate in the competition, the suppliers have to meet certain eligibility criteria/requirements, and will be evaluated according to predetermined selection criteria determined by the operator. This introduces the framework for who wins the tender process, which is whether the most economically advantageous offer, or the offer with lowest price [10].

The parties involved in oil & gas projects are the Norwegian Ministry of Petroleum and Energy (MPE), the licensee(s) and the service supplier(s). Upon new field discoveries, exploration & production (E&P) companies submit the plan for development and operation (PDO) to the MPE who grants the production license, and thereafter appoint or approve an operator that will be responsible for the daily management of the joint venture’s activities (Section 3-7 of the Petroleum Act (PA)) [8].

The PDO describes development of the project and includes estimates for schedule, quality and cost. It requires comprehensive project planning. An accurate cost prediction is hard to determine because O&G projects are technically complex and depend on many factors. Operators therefore add a range of uncertainty in their PDO estimate (usually 20%) which serves the purpose of giving a reasonably accurate estimate that accounts for unexpected events.

Offshore oil & gas projects are extremely comprehensive and consists of many independent activities. A successful project require quality in all sections, including qualified contractors and sub-contractors. Since activities in a project often occur simultaneously and on several geographical areas, suppliers are required superb cooperation and communication.

3.2 Project life cycle & risk management

For simplicity, offshore oil & gas projects are separated in two phases, a planning- and an implementation phase.

The life cycle of a project starts by a sequence of processes that includes defining project goals, planning, implementation, monitoring and control. These sequences include project defining, feasibility studies, determining quality design, contracts, construction and commissioning.

The planning phase is a crucial phase because it sets the foundation of the entire project. A well-established planning phase is considered a precondition for success in the implementation phase in terms of cost, quality and schedule. It involves determining the total work scope, creating a plan for implementation, consider offers from suppliers, choosing contractor(s) and selecting a suiting contract strategy. An ideal contract consists of clear and precise instructions in order to support good communication between the parties and decrease the risk of any misinterpretations. Furthermore, the planning phase involves calculating realistic estimates for project- performance, cost requirements and implementation times with built-in flexibility to account for potential project changes.

Through studies of feasibility and concepts and front-end engineering (FEED) systems, the project can advance in details through a number of sequential stages. Following each stage, an evaluation decides whether the project is considered economically viable [8].

The implementation process on the Norwegian Shelf consists of many decisions throughout the projects life cycle. Internal and external quality assurance are performed prior to each decision. The implementation phase involves detailed engineering, construction, commissioning and hook up of the facility. The detailed engineering includes the final sketches for the facility, including accurate calculations of weight, space and material requisites and available resources, and the procurement begins. At this stage of the project, the facility is installed and therefore the responsibility is transferred from project organization to the operations management organization [11].

Project follow-up in the implementation phase involves checking up on contractual relationships, securing correct cost development, guiding the construction workers and checking up on procurement of material and quality control. Depending on the type of contract, the operator and contractor divide these tasks among themselves. Regardless of how these tasks are distributed, the operator will always be the responsible part.

Oil & gas processing facilities are extremely complex and require integration on a diversity of technical disciplines. It therefore puts high demands on the quality in the technical development and implementation process in order to get the required functionality. With complex projects comes greater risk. The investments in these projects are irreversible and yields no revenue until after production start. The development and implementation times are usually 2-3 years and 3-5 years, respectively. Furthermore, any project complications will cause more setback to profitability. There are often limited options for splitting (breaking) up the scope of work for decreased risk since the facility is normally indivisible**.**

Moving the facility to another location is typically not a viable option because of limited options of redeployment of equipment. It is clear that risk management is a vital part of project management in all phases of the project, and it is for this reason that the project planning occurs in a staged process. Offshore projects are unique and since all development costs are irreversible, every investment decision comes with major commitment.

Optimal risk sharing in oil & gas contracts have traditionally been achieved through partnerships (licensee groups) - risk spreading among the operator and several licensees. In this way, oil companies have efficiently been more capable to take on risk than contractors have.

Basics within contract theory is that risk sharing must balance two relations, optimal risk sharing vs incentives. Because of financial solidity, the operators are more capable of handling risk than the contractor. However, if the operator takes on too much risk, the contractor will remain with a fixed payment therefore weakened incentives to deliver according to plan and quality [7,11].

3.3 Responsibility and ownership

The Norwegian Government is according *petroleumlaw*, 1996 §1-1 the rightful owner to all petroleum resources on the Norwegian shelf. Production of petroleum other than the state itself requires consent from the government. The consent gives permission to produce petroleum, and if granted, the operator will own the resources [8,10].

The operator for an oil & gas project on the NCS is the liable party for the project, and therefore it is highly necessary that the operator is qualified with the required competency, qualification and knowledge to the Norwegian Shelf. The licensee is according to Petroleum Act Section 1-3 overall responsible for the safety of the operation and all its activities. Furthermore, the operator is responsible for choosing qualified suppliers and sub-suppliers. A prerequisite for a successful project is competency and quality in all parts of the project.

The licensee is according to modern statutes bound to pursue a follow-up duty that is called "supervisory duty". The duty require the licensee to make sure all parts performs the provisions of work in pursuance of the Act. The operator have direct management and is responsible to sustain the quality of the performance. This involves guaranteeing requirements, terms and conditions, as well as sustaining quality and efficiency.

Although the operator is the responsible the daily management of the operation, the operator must always act, and make decisions in compliance with the other licensees. The joint ventures are individually required to perform audits to ensure the operator is on track and acts according to the rules. Furthermore, supervising the project and contribute to steer the project in the right direction is also a major part as licensee. To improve quality, licensees must contribute with experience and competence within their companies, in both development and implementation phase.

The "supervisory duty" serves the purpose of ensuring the operator performs all obligation correctly. This involves having efficient management system, satisfactory organization, possess sufficient capacity, obtain necessary permits and consents, etc.

"Supervisory duty" is a comprehensive follow-up duty that consists of a general set of rules and regulations for performing petroleum activity on the NCS. The follow-up duty applies in the development phase, before and after signing contracts, and also in the implementation phase, when verifying that all participants contains the required competence and qualification to perform petroleum activities. Reporting regular status, nonconformities and measures to the management committee is required.

3.4 Cost development

3.4.1 Norwegian Continental Shelf

Most projects on the Norwegian Shelf are completed within the uncertainty range estimate (± 20% change). Table 3.1 shows major oil & gas projects on the Norwegian Shelf between the years 2007 and 2012, and their planned vs actual cost.

Table 3.1 Major development projects on the NCS [8].

Project	PDO/PIO approved	PDO/PIO estimate	New estimates	Change	Change %
Atla	2011	1 382	1 382	0	0%
Brynhild	2011	4 227	4 579	352	8%
Edvard Grieg	2012	24 205	24 205	0	0%
Ekofisk Sør	2011	28 022	27 237	-785	-3%
Eldfisk II	2011	37 987	37 893	-94	0%
Gaupe	2010	2 828	2 376	-453	-16%
Goliat	2009	30 942	37 142	6 200	20%
Gudrun	2010	20 592	18 976	-1 616	-8%
Hyme	2011	4 593	4 780	187	4%
Jette	2012	2 590	2 909	319	12%
Kårstø Expansion Project 2010	2008	6 675	6 297	-378	-6%
Knarr	2011	11 437	11 527	90	1%
Martin Linge	2012	25 641	25 641	0	0%
Marulk	2010	4 162	4 476	314	8%
Oselvar	2009	4 937	5 120	183	4%
Skarv	2007	35 632	47 162	11 530	32%
Skuld	2012	9 895	10 147	253	3%
Stjerne	2011	5 263	4 976	-287	-5%
Valemon	2011	26 329	26 880	551	2%
Valhall Redevelopment	2007	25 163	46 727	21 564	86%
Vigdis Nordøst	2011	4 194	4 467	273	7%
Visund Sør	2011	5 296	5 208	-88	-2%
Yme	2007	4 894	14 114	9 220	188%
Åsgard Compression	2012	15 661	17 693	2 031	13%
Total		342 547	391 914	49 366	14%

Most projects in this list show minimal change from their PDO estimate. However, some projects have on the other hand lost control, resulting in substantial cost overruns. Yme, Skarv, Goliat & Valhal VRD (highlighted) alone consists of 98% of the total cost overruns. It is therefore important to analyze such disastrous projects in order to find out why some projects drastically spin out of control, while others manage to keep costs according to plan.

3.4.2 International

Excessive cost overruns and time delays in certain oil & gas projects are not exclusive to the NCS, and can be observed all over the world. Research done on a global level from other industry branches suggest major projects all the world generally experience cost overruns and delays.

Audit and consulting company EY (Ernst & Young) published a study called “Spotlight on oil and gas megaprojects” based on the 20 largest upstream projects within the oil & gas industry. Results suggested projects on average resulted in cost overruns of 65%, which summed up to 76 billion USD, or 440 billion NOK, which is 22 billions NOK per project.

A more comprehensive study made by EY involved tracking of 357 projects, all of which have greater investments than 1 billion USD. Of all the projects in the study, 194 of them showed an updated cost estimate, and 57% of these projects showed cost overruns, and 64% experienced time delays. The study also examined whether the geographical location were linked to projects with overruns, but this theory was disproved by the data.

A study initiated by IPA (Independent Project Analysis) analyzed major projects in different industry sectors, which had an investment sum greater than 1 billion USD. In this study, a project would fail if the cost overrun exceeds 25%, if the project exceeds 25% of the average industry cost overrun, if project time delay exceeds 25%, or if the project implementation time exceeds 50% over the industry average, or if the projects experience major project issues within the first two years of the project. Almost all the projects scored with low success rates, but the oil & gas industry scored lowest, with an average success rate of 22%. Independent of industry, major projects scored an average of 35%, while all projects regardless of size scored an average of 50% [8].

4 Contract structure on the NCS

4.1 Separated vs larger contracts

An operator have to decide whether to approach the project with separate or larger contracts. Smaller contracts contain few activities, for example only engineering, while larger contracts include several activities, such as engineering, procurement and construction, also called EPC.

The deciding factor is the company's competence, experience and preferences. Having separate contracts for engineering and procurement will create more interfaces for the operator, but it will also create more control over each activity. In this way, the operator can choose the supplier with best expertise for installation, and another supplier with best expertise for procurement.

Figure 4.1 illustrates different activities in offshore field developments.

	Engelsk	Norsk
E	Engineering	Prosjektering
P	Procurement	Innkjøp
C	Construction	Konstruksjon
I	Installation	Installasjon
C	Commissioning	Uttesting
H	Hook up	Sammenstilling
F	Fabrication	Fabrikasjon

Figure 4.1 Main activities included in contracts for offshore projects [8].

A contract strategy can involve a relatively small technical segment and consist of pure fabrication contracts. In this way, the operator is able to follow development in the project more closely and "stand in the middle" between the contractors for design on one side and fabrication on the other. This contract strategy requires a high degree of follow-up, control and monitoring of many interfaces between the contractors. Smaller contracts would also mean more competitors in tender process as each contracts involve less commercial and financial risk. It is reasonable to assume that companies with major resources would prefer this contract model, while smaller and newly established companies with fewer resources would not undertake this contract model.

The traditional contract structure in the Norwegian offshore industry consists of several suppliers. This organization model is distinctive because the operator enters individual contracts with each supplier. The traditional contract structure forms a pyramid, as observed in Figure 4.2. In this structure, we see that there is no horizontal relations between each supplier.

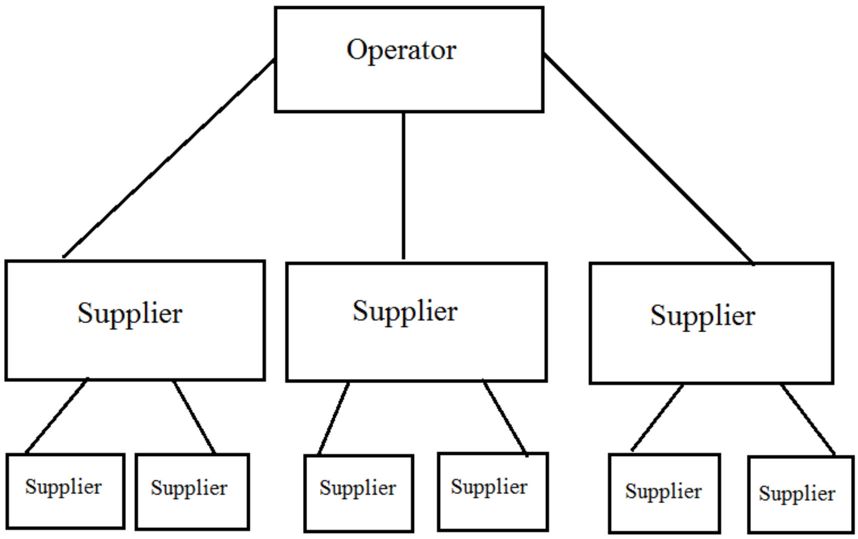

Figure 4.2 Separate (traditional) contract structure

In recent years, the typical contract strategy have changed and it has become more normal for projects to consist of a main contractor with several activities. Combining several activities in one contract is called a *total contract.* It will normally include engineering, procurement and construction (EPC) but in some cases also installation (EPCI) and commissioning (EPCIC). When the operator wants a complete product, it is referred to as a *turnkey* delivery.

The main contractor will still require sub-contractors, either in form of direct procurement of goods, services, or through tendering. In this way, we observe a hierarchy of contracts. How many levels the hierarchy varies greatly between the contracts. Figure 4.3 show the contract structure with one main contractor with individual sub-contractors.

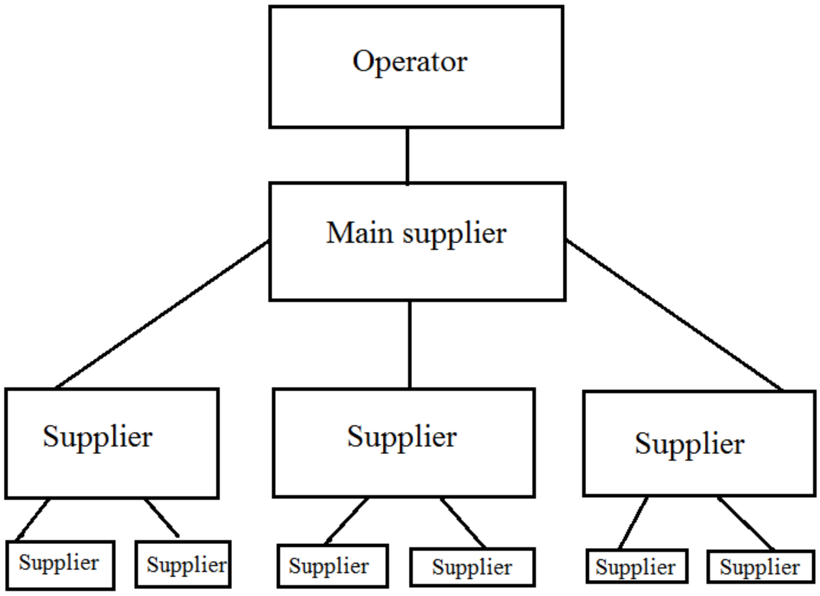

Figure 4.3 Larger contracts with one main supplier

EPC-contracts have proved to reduce costs and are a widely used contract strategy in the Norwegian offshore industry the past years. Oil companies can pay more attention to how themselves can run the operation in a more cost efficient way. This is important because new field discoveries are typically smaller and found on greater depths, which results in projects with marginal profit. The contractor can then more easily coordinate overlapping activities (reduces double work between suppliers) and receive a greater potential reward.

In such contracts, the operator transfer economic and commercial risk to the contractor. Holders of major EPC contracts must be of significant size to handle this risk. Such contracts requires a high level of competency for the contractor, and it introduces more responsibility and risk. Experience show it is recommended to use standardized contracts, such as the *Norwegian total contract* (more in chapter 4.3.1) order to ensure important legal rights for the contractor and contribute to a balanced risk profile.

EPC-contracts entail advantages and disadvantages seen from the operator's perspective. On one side, the project will require less monitoring and follow-up because the responsibility is transferred. Furthermore, in such large contracts, there will be less need of smaller contracts, which mean less number of interfaces between the operator and contractor, and therefore eliminating the need for operator to monitor the subcontractors. Experience shows that this is a very time consuming job in development projects.

On the other side, a disadvantage following the EPC-contract is that the operator will be notified later if unforeseen events occurs. This can be in form of design changes or deviations from fabrication work. This can cause significant problems and delays in development projects.

Figure 4.4 show the probability of development costs with traditional contracts *g(K)* vs EPC-contracts *f(K).*

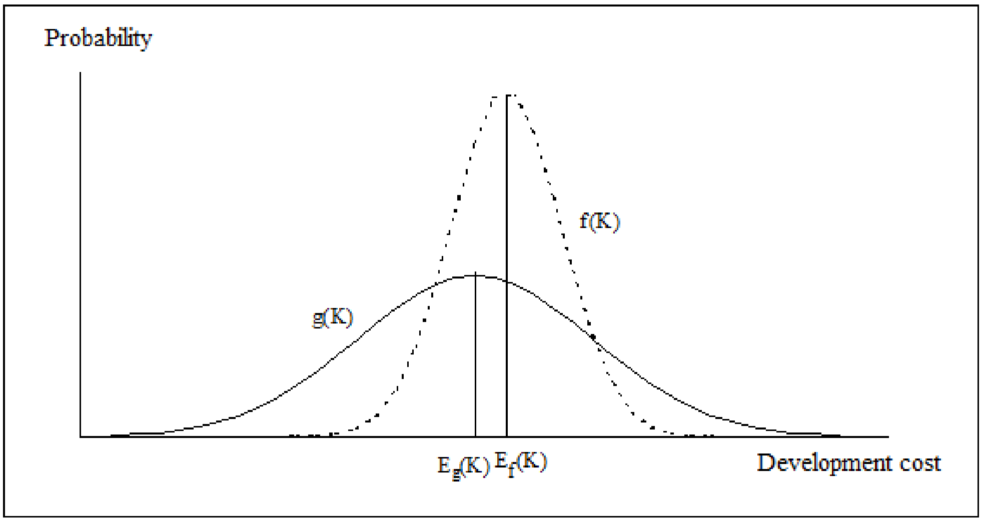

Figure 4.4 The probability distribution of development costs associated with traditional tender contracts (g(K)) vs EPC-contracts (f(K)). Figure modified from [4].

The figure show that the expected development cost of a project is considerable lower for EPC-contracts than with traditional tender contracts. However, the uncertainty is also a lot higher. The possibility of cost overruns or that costs are lower than expected is significantly higher with EPC-contracts. Because of the risk sharing that is achieved through licensee groups, this is a risk many oil companies are willing to take as long as it will provide savings in the long run.

4.1.1 Risk tradeoff

There will always be a tradeoff between how much risk the contractor should hold. Deciding factors will be size of the project, degree of technical complexity of the development concept, size of contractor and the amount of qualified contractors. The amount of capacity within the most attractive contractor will be deciding for the chosen contract strategy.

Few companies are willing to take on the substantial risk that follows *total contracts*. For the operator company, few competitors in tendering will most likely result in a high price. It is also a risk that the operating company will be left with the bill if the contractor fail to carry the risk exposure following the contract. It is normal to operate with formal constraints on the contractor’s responsibility, for example, costs following time delays will not be covered. Furthermore, it is important to note that even though a contractor bears most of the risk involved, the operator is still responsible for HSE and the project will require close supervision, regardless of contract model.

4.2 NORSOK

In the beginning of the 90s, the petroleum industry realized it needed desperate measures to reduce costs. In the year of 1993/94, NORSOK was created with intention of strengthening competitiveness among Norwegian players. The government, operators and contractors gathered to find new organization models and find more effective contracts with the intention of decreasing project cost and time. The plan was to reduce project time by performing more parallel work and letting the contractors participate earlier in the process of concept studies. Furthermore, the integrated work between operator and supplier would open up for possibilities such as developing the PDO estimate simultaneously with procurement. At the same time as the NORSOK process started, it was becoming more normal for projects to have one main supplier (total contracts), instead of separate contracts like before. This contract model would put more risk and responsibility on the supplier.

The NORSOK process resulted in reduced costs overruns, but not as much as expected. It is important to note that cost overruns not necessarily means bad productivity level. The cost overruns only tell us the difference between the expected- and actual project cost. This can therefore also be due to overly ambitious cost estimates. However, results indicated that cost was reduced after the introduction of the NORSOK process [4].

4.3 Standardized contracts

Several standardized contracts have been developed by Norwegian oil companies and suppliers due to the rising amounts of projects in the 90s. Construction and modification of installations on the Norwegian Shelf have in the recent years followed the standardized contracts Norwegian Fabrication contract (NF), Norwegian total contact (NTK) and Norwegian total contract modification (NTK MOD). After many years of work, Norwegian operators and contractors have together developed standardized contracts.

It is essential for the parts to ensure that the standardized contracts have support and anchoring in the industry. The purpose has been to develop more efficient, reasonable and cost effective solutions on the NCS [13].

In international context, the NCS is characterized by unique and extensive use of standard contracts, developed and negotiated jointly by the industry’s biggest operator and supplier interests since the 1980s. The major Norwegian operators Statoil (and former Saga and Hydro) has been obliged to commit to these standards.

4.4 History of Norwegian total contracts

Norwegian total contract 2000 (NKT 00) was initiated because many contracts in the 90s were unpredictable and imbalanced in regards of risk, also very few suppliers carried the equity to handle large potential cost overruns and delays. The contract was negotiated between the Norwegian state oil company (Statoil) and Norsk Hydro from the operator side and *Teknologibedriftenes Linjeforening* (TBL) from the supplier side. The NTK 2000 is one of the most common contracts used on the Norwegian Shelf. The contract regulates conditions for engineering, procurement, construction and installation.

Norwegian total contract 2007 (NTK 07) is an improved version of NTK 2000 and is developed by *Statoil* and *Norsk Hydro* on the operator side and *Norsk Industri* on the supplier side. The developers, including companies that are member of *Norsk Industri*, have all committed to use NTK 07 in all projects that involve engineering, procurement, construction and installation (EPCI) on the Norwegian Shelf.

The most recent version is the NTK 15 has reflected the current economic situation (high cost level and low oil price) and shifted the pressure over on the supplier side. The suppliers are required to show strength during the contractual negotiations. The changes are necessary to provide more flexibility in a tight market where O&G companies are pressured. NTK 15 are the first steps towards tougher standard contracts on the NCS.

The biggest change from previous versions is that the obligation to use the standardized contract is removed. Several conditions from previous versions have now been left out, which therefore need to be negotiated in a separate agreement between the parts [14-16].

5 Study of major development projects

A general and global trend is that projects are becoming larger and substantially more complex. As opposed to smaller, conventional projects, bigger projects entail more risks with regard to technology, environment and finance. However, enormous construction projects in themselves provide employment and potentially great economic value for the society when finished.

The rising trend is also observed in Stavanger. Several local projects have recently been referred to in media *Teknisk ukeblad.* One of them is the high school “Jåttå Videregående” which cost NOK 844 million to build 6 years ago. The building recently experienced significant rot, even though maintenance was not required due to the material that was used (untreated wood). In retrospect, experts reveal the material was not the cause, but poor design and engineering work. A similar incident occurred for another high school “Vågen” which cost NOK 400 million [28].

In Stavanger, bigger projects are also arising in the transportation sector. Norway’s largest transportation project is in its planning phase. E39 Rogfast from Randaberg to Bokn municipality, worth NOK 13.8 billion, will be the world’s longest undersea road tunnel when completed. Another major construction project is the development of E39 Ryfast, worth NOK 9.3 billion, which also will consist of complex undersea road tunnels. These projects can be considered pioneering work, as they require a higher level of comprehensive engineering and technical competency than experienced in past projects [29]. With enormous and complex projects come greater uncertainty and risk. Troubling development projects has become a general trend and appears across the nation in many industry sectors.

A study will be conducted, to analyze four major development projects that have failed or partly failed. The analysis aims to explore why major projects do not go according to plan by examining important elements. This study will further point out common pit falls and extract lessons.

This analysis is conducted on basis of four major development projects across two industry sectors. Three of the projects are from the petroleum sector, and one from the transportation sector.

- Yme
- Goliat
- Valhall redevelopment
- E6 Langslett-Sørkjosen

5.1 Yme

5.1.1 Field description, history & redevelopment

The Yme field is located in the central part of the North Sea, approximately 100 kilometers from the Norwegian Coast. The water depth is approximately 93 meters. The field was discovered in 1987, first developed by Statoil and produced oil between the years 1996-2001. Production ceased and the field was abandoned due to low oil prices. Approximately 15% of the original oil in place was produced. A new license group led by Talisman Energy AS was formed to re-develop the field, the first field ever to be re-opened on the Norwegian Shelf [18]. The licensees' share of project Yme is illustrated in Figure 5.1.

Licensees June 2013	
Talisman Energy Norge AS	60%
Lotos Exploration and Production Norge AS	20%
Wintershall Norge AS	10%
Norske AEDC A/S	10%

Figure 5.1 Licensee's share of project Yme [8.]

Talisman submitted the PDO to the Ministry of Petroleum Department (MPE) on the 9th of January 2007, and was approved by the MPE on 11th of May 2007. The field development in the PDO entailed seven producer- and five injector wells. Estimated recoverable reserves was 14.1 million Sm^3 oil, and production scheduled in February 2009. The re-development of project Yme would consist of three main elements.

1) Drilling and completion of production and injection wells
2) The engineering, procurement, construction and installation ("EPCI") of the subsea production facilities, pipelines and umbilical; and,
3) The EPCIC of a mobile offshore production unit with storage ("MOPUstor" or "MOPU")

Talisman Energy AS entered an EPCIC-contractual agreement with Single Buoy Moorings inc. (SBM) to build the MOPU on a turnkey basis. This contract would include engineering, procurement, construction, installation and commissioning. In the agreement, SBM would be the owner of the MOPU, and the licensees of the project were to pay rent to SBM under a so-called Bareboat Charter agreement throughout the field's lifetime.

SBM constructed the topside "MOPU" in Abu Dhabi, the tank ("stor") in Malaysia and the legs fabricated in Germany. The MOPU and legs were to be assembled at Rosenberg, Stavanger, prior to installation and offshore commissioning at Yme.

The storage tank was successfully installed on field in summer 2008. The drilling and well completion, as well as the subsea production facilities, pipelines and umbilical's were also finished on time in 2009 according to schedule.

The construction of the MOPU on the other hand, experienced significant delays. The production unit was finally installed at the Yme field in summer 2011, 3 years later than planned. The operator, Talisman, observed serious faults and defects on the MOPU. Work that was supposed to be completed at the shipyard in Abu Dhabi, had to be operated offshore, which caused further delay. According to the contractual turnkey agreement, the MOPU was to be delivered completed and commissioned.

Due to discovery of significant structural design faults and cracks in the foundation, which fastened the MOPU legs to the storage tank on seabed, Talisman decided to remove the personnel from the field. The owner of the MOPU, SBM, decided later in December 2012 to scrap the production unit. The project described in the PDO from Talisman Energy AS was never realized [19]. Figure 5.2 shows the historic timeline for project Yme.

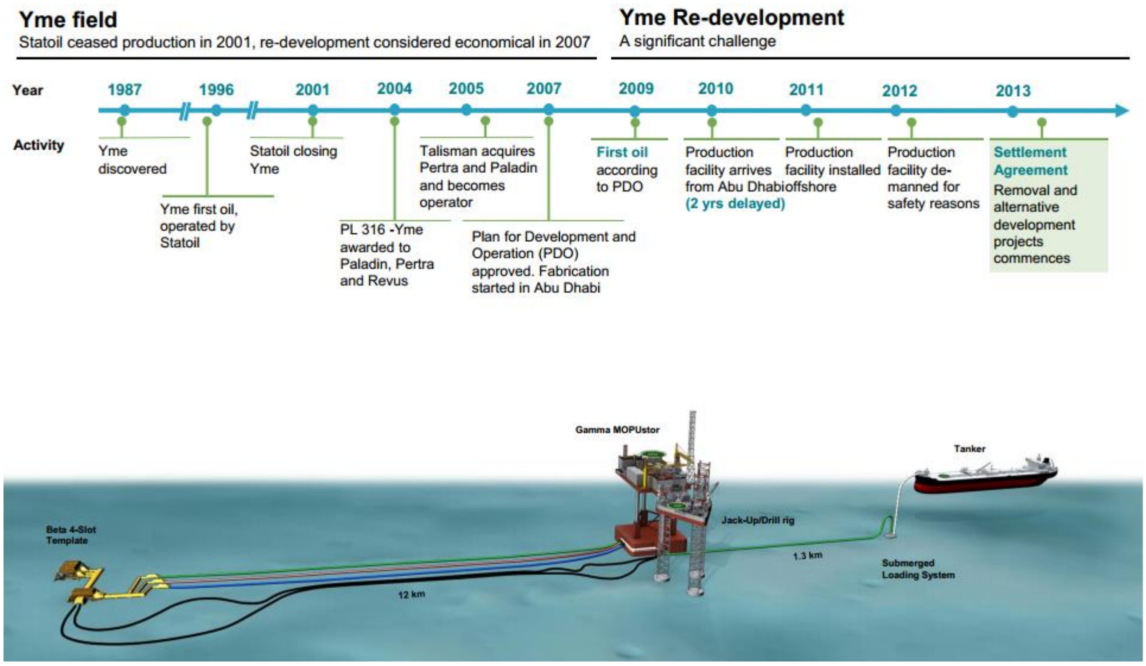

Figure 5.2 Historic timeline of project Yme [19]

5.1.2 Cost development

Table 5.1 explains the cost development from the PDO estimate to the realized cost. The numbers are collected from the operator.

Table 5.1 Planned and actual cost development for the Yme project [8].

	MNOK 2012 at PDO	MNOK 2012 Dec. 2012	MNOK 2012 increase	% increase
Wells	3076	4299	1223	+40%
Subsea facility	1159	1350	192	17%
Mobilisation and insuring facilities	209	3595	3386	1620%
Project management	450	2315	1865	414%
Total	4894	11558	6664	136%

An additional production well was drilled compared to the PDO description. Cost complications related to wells were higher than planned due to adjustments for unexpected coal formations that led to drilling of extra sidetracks. Accounting for such contingencies is normally a common practice when estimating costs, and since it was not included in the PDO estimate, the drilling cost estimate can be considered optimistic.

The enormous cost increase for “Mobilization and insuring facilities” is due to financial contributions from Talisman and other licensees to SBM during the execution phase. The purpose of these contributions was to speed up progress and improve quality. Since such contributions were not a part of the original agreement, “side agreements” were formed to deliver payments. These payments could naturally not be foreseen and therefore was not accounted for in the PDO. Since only a small amount of the budget was considered for “Mobilization and insuring facilities” the cost resulted in a staggering 1620% increase.

The problems and delays at the shipyard resulted in an increased need for own follow-up from the operator during the construction process, which caused a 414% increase in the operator’s “Project management” costs.

5.1.3 Project experience

The operator admitted insufficient work in the early phase of the project. The PDO was poorly planned and optimistic. They especially lacked a sufficient internal decision system with quality assurance and maturing of projects up to a final project approval. The detail engineering was initiated before completion of the FEED phase. Further, fabrication and procurement initiated too early compared to the completion of detail engineering.

The field's lifetime was very uncertain, and the profitability considered economically marginal. With regard to the projects present value, the licensees' decided to spread the costs over the projects lifetime. Hence, it was decided in early screening phase to base the development solution on a leased concept. Talisman did not have as much development experience as many established competitors. The operator only had experience in developments projects in the United Kingdom (UK), and therefore hired Norwegian workers who earlier had been engaged in projects on the Norwegian Shelf. The uncertainties made it clear that a leasing concept with a lump sum EPCIC-contract made sense, as the majority of implementation risk would be transferred to the contractor.

The drilling & completion of subsea facility was implemented within time and cost. Therefore, the project experiences will mainly focus on design and construction of the MOPU as this part caused significant rework, cost overruns and delay.

There were in general few competing candidates in the tender process, and SBM appeared to be the only real candidate. The other competitors were considered unqualified and would not able to take on the risk. Furthermore, the SBM's MOPU solution seemed attractive. It was able to carry out well intervention, which was an important criterion for the operator. It was also able to provide "dry" wellheads and oil storage. SBM owned Gusto Engineering, which had developed the MOPU concept. Furthermore, Statoil had earlier used the same concept when operating the Danish Siri field, and hence it would most likely suit petroleum activity on Norwegian shelf as well. The contractor was considered the world's largest operator of FPSO's (Floating Production, Storage and Offloading) and was able to show great HSE (Health, safety and environment) statistics and experience with multiple shipyards in Asia.

A concern was that neither operator nor contractor had previous experience in implementing projects on the Norwegian Shelf. Therefore, the complexity and requirements to Norwegian standards was identified as an implementation risk. The risk was not heavily weighted in the licensees' choice of contractor, and Talisman was impressed with SBM's references and history.

SBM's top priority was not quality or following Norwegian standards requirements. Their strongest incentive was to complete the production unit and start collect rental income. The project was therefore schedule-driven from day one.

Before submitting the PDO, the operator was aware of the implementation risk that followed the contractors lack of knowledge of Norwegian requirements and standards. This concern was addressed with seminars, courses and follow-up from the operator with the purpose of reducing such risk. In practice, however, a lot of rework had to be done throughout the construction phase due to the lack of understanding of Norwegian regulations and standards. Nonconformities was observed in all system areas, particularly within technical safety and working environment.

According to the current contract form, the parts did not emphasize a particular need for project follow-up from the operator's side, and therefore, the operator's project team in Abu Dhabi only consisted of a small team of experienced Norwegian professionals. Due to the increasing number of nonconformities, the operator had to send more staff and personnel to help follow up the project. This led to discovering of even more nonconformities and increased costs, and at this stage, much of the work had already been completed. The contractual form with SBM as the owner restricted the operator's ability to influence the implementation solutions, as well as perform inspections, interventions and close follow-up.

All unconformities during the construction phase was according to the contract supposed to be fixed. Hence, many of the disputes between operator and contractor was about deciding what parts needed correction. The contractor did not seem to have adequate incentive to fix all unconformities free of charge, and therefore “side agreements” were formed to improve progress. These agreements would included intervention payments to subcontractors and resource support (personnel/equipment). These measures proved ineffective concerning progress and quality, and mostly resulted in more disputes.

When the production unit eventually left the shipyard in Abu Dhabi it involved many defects. These defects had to be corrected in Norway at a substantially higher cost. The MOPU, with its flaws and defects were only approximately 74% complete. To save valuable time and money, it was decided to place the production unit on the field instead of on land (completing work offshore is more expensive than on land).

After the MOPU was installed on the Yme field, several reports were filed to the PSA (Petroleum Safety Authority Norway) regarding lack of trust to SBM and serious HSE related issues. Many subcontractors working on the field stated that the lack of quality compromised the safety. Moreover, others stated that they did not care to report HSE deviations because they did not believe SBM would do anything about it [35].

In July 2012, Talisman discovered significant structural flaws and cracks in the foundation of the MOPU, and decided to evacuate all personnel. In December 2012, SBM decided to scrap the MOPU.

5.1.4 Lessons learned

Many mistakes were related to the decisions made in the early phase of the project. Some of the most important extracted lessons from this project are:

1. Thorough work in the early phase
    - Have an internal system which ensures maturing and quality towards final project approval
    - Spend more time in the early phase, adequate time to complete the FEED phase before PDO submission and detail engineering

- Proper prequalification of contractors with regards to quality, experience and expertise

2. Understand the consequences of an EPCIC-contract with 'lease'.
3. It is important to participate and influence solutions in the implementation phase. Setting the standard early in the project will help ensure deliveries in accordance to contract stipulations.
4. Anticipate a larger need of project follow-up which include enough expertise and capacity as well as own expertise in Norwegian standards and requirements

5.1.5 Reflection

This part is a reflection of the project experiences and lessons learned, mostly concerning the contract format and interaction between the operator and contractor.

Overview

Yme, as many other implementations on the Norwegian Continental Shelf, rushed the date for first-oil and suffered the consequences of not having an adequate internal system to ensure maturing and quality towards final project approval. The project got off on the wrong foot due to insufficient early phase planning. Moreover, this type of platform and concept had never been installed on the Norwegian Shelf, and it was largely considered a pioneering project. This caused further complications because the contractor's focus was time-driven, which ultimately compromised the quality. Yme is considered the single worst project ever implemented on the Norwegian Shelf as the project entailed enormous cost overruns, significant time delay, never reached first-oil and hence caused no spin-off effects that would provide the society with industry, employment or governmental earnings through taxation of production.

Divergent objectives from the two parts

The basis for the contractual agreement of the MOPU was a *turnkey* delivery with fixed price elements. Subsequent to contract formation, the operator's priority was to ensure quality on the production unit. From the contractor's perspective, the execution phase was very schedule-driven with the current agreement. The parties' did not share congruence to the same extent, and the contractor lacked incentive to adapt to the unusual high quality requirement for Norwegian projects. The most important incentive for SBM was to start collecting rental income.

Lack of compliance with Norwegian requirements

The key problem for the operator appeared to be the contractor's lack of ability to comply with the Norwegian requirements. The operator struggled to communicate these standards to the subcontractors on the field because all rework had to go through the owner, SBM. Due to the lease concept, the operators felt distanced from the subcontractors. Therefore, arguments between the parts occurred because nonconformities was not always fixed, especially within technical safety and working environment. The concern was initially addressed with seminars and courses, which works as a communication channel between the parts. It is reasonable to question the efficiency in these formal meetings and if maximum effort was performed for ensuring friendly relationship and a sufficient understanding of the NORSOK standards.

Lease concept vs build-to-own

The 'lease concept' created a certain power distribution in the execution phase, which shifted in the favor of the owner (SBMs). A 'build to own' contract model would have influenced the power distribution between the parts, making it easier for the operator to perform inspection, interventions, follow-up of the subcontractors and to influence the solutions implemented. With the current leased concept model, these rights were significantly compromised. After a possible completion, the MOPU could be sold, and the leased back to the operations phase.

5.2 Goliat

5.2.1 Field description & history

The Goliat project is the first developed oil field in the Barents Sea and is located 88 km North-west from Hammerfest. The licensees are Eni & Statoil, with Eni as operator. The licensees' share is illustrated in Table 5.2.

Table 5.2 Licensees share of project Goliat

Licensees'	Share
Eni Norge AS (operator)	65%
Statoil Petroleum AS	35%

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The PDO application for Goliat was approved by the MPE in 2009 with a scheduled production start in 2013. The total production is estimated to 179 million barrels of oil equivalents over a 15-year period. Figure 5.3 show the location of Goliat outside Hammerfest.

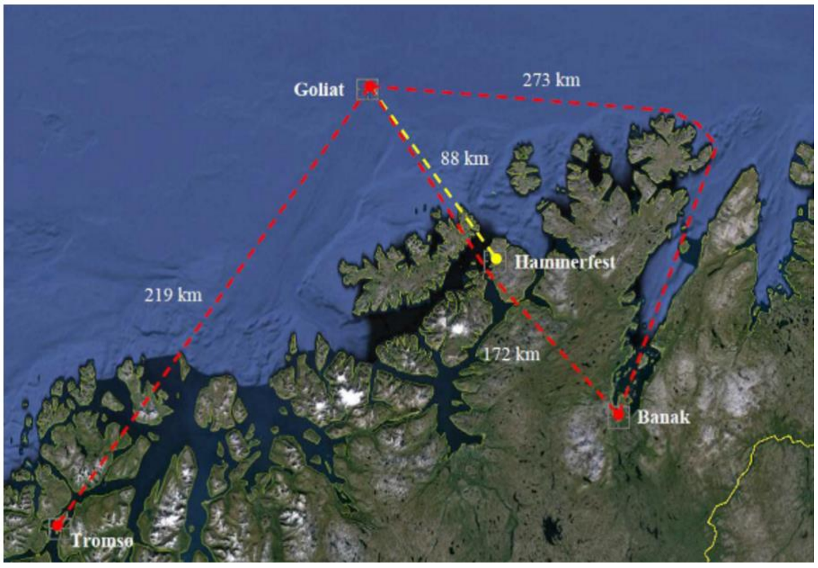

Figure 5.3 Location of the Goliat Field outside Hammerfest [20].

The Goliat field is developed with a Floating Production, Storage and Offloading (FPSO) designed by Norwegian Sevan Marine and built by Hyundai Heavy Industries (HHI) in Ulsan, South Korea. The FPSO is a cylindrical production unit with process plants, oil storage and living quarter, specially designed for the climate in the Barents Sea. The construction of the FPSO is an EPC-contract, which involve fixed-price elements and full responsibility within engineering, procurement and construction of the floater.

Approximately 65% of the contracts went to Norwegian suppliers. The major contractual agreements in the development project are illustrated in Figure 5.4.

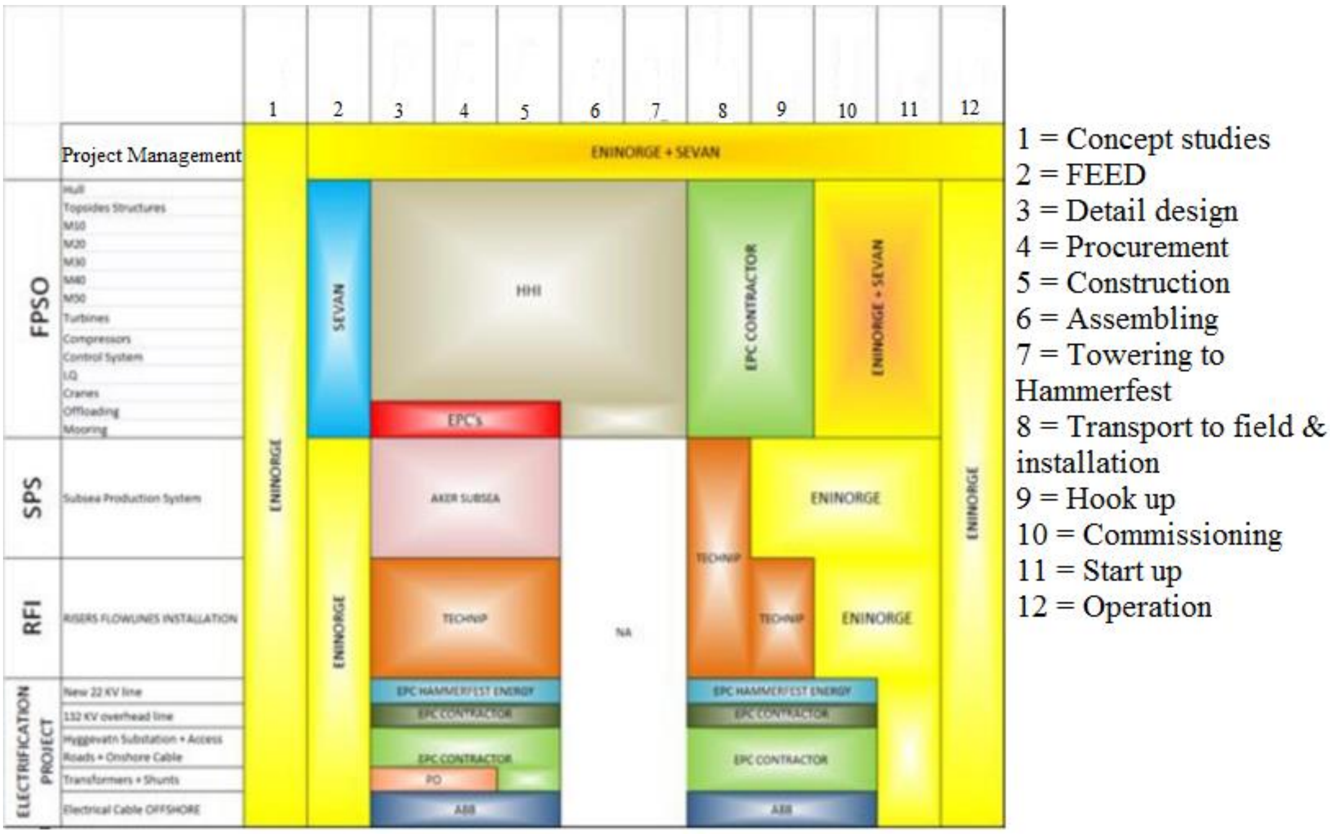

Figure 5.4 Goliat contract strategy in development & technology area. Modified and based on [21].

Eni Norge, and partly Sevan, is responsible for the project management from the early phase of concept studies to development and operation.

The largest contracts are located on the left side of the figure. For the FPSO, Eni is responsible for concept studies and evaluation, Sevan for the FEED phase and HHI for the detail design, procurement, construction, assembly and transport to Hammerfest. In parallel with this phase, other EPC-contractors are working on systems that shall be on board the FPSO.

As a helicopter view of the development, the project experienced significant delay and cost overruns due to problems with the FPSO in South Korea, and further problems after installation on the field in the Barents Sea. The FPSO arrived the field in April 2015. Production started March 2016, three years delayed.

5.2.2 Cost development

Due to no, official project report regarding experiences from the Goliat project, the following part is based on details "Teknisk ukeblad" have collected from the MPE [22-24,30,34] and expert opinions from professor Ove Tobias Gudmestad at the University of Stavanger.

Eni submitted the PDO in 2009, with an estimated project cost of NOK 30.9 billion. This included all costs related to project management, construction of the FPSO, subsea facility, wells and onshore power plant with electric cable.

The realized costs (October 2016) are more than NOK 50 billion, which corresponds to a cost overrun approximately 62%. Eni claim macroeconomics are responsible for the majority of the overruns, and explains that the PDO was submitted during the financial crisis, when contractors and shipyards were desperately looking for work. By the time implementation started, the market turned, which led to substantially increased time delivery and project cost, which applied to both for international and national suppliers. The operator claim that because of the high activity level, the project would have experienced cost overrun regardless of the shipyard's geographical location. On several occasions, Eni was forced to pay the bill when the contractor lacked expertise or capacity, including paying for the documentation of performed work at the shipyard.

Overall, the report highlighted the following causes for cost overruns:

- ✓ A market trend of increased cost profile
- ✓ Additional costs to complete remaining work on the FPSO
- ✓ Transport of the FPSO
- ✓ Project follow-up
- ✓ Modifications on drilling rig
- ✓ Offshore installation delay

5.2.3 Project experience

The implementation solutions on Goliat were technically complex and special designed for the Barents Sea, which was a challenge at the shipyard in South Korea. Compared to Norwegian’s competency within implementation, The Koreans were great at procurement and fabrication, but did not have the same engineering capability. Since the South Korean shipyards have long traditions in shipbuilding, it has therefore been challenging to adapt to complex offshore projects. Goliat was in many ways considered a pioneering work. The engineering work was mentioned as a significant factor for the delay; as it resulted in a lot of re-work. The re-work required substantial resources for project follow-up. Eni’s site-team consisted of 374 employees, included external consultants.

The shipyard in Ulsan was on several occasions criticized for its poor HSE regulations. According to the largest work union in Korea, thirteen workers lost their lives on the shipyard in 2014. So far, three persons have died working on the Goliat project. Eni have stated that the project has been time-driven which may have caused a compromise on the workplace safety and the integrity of critical equipment [23].

The problems continued on the field after the FPSO was installed [30]. In a letter from the staff signed by the *Norsk Industri*, the following concerns was reported from the field concerning HSE and cultural issues between the Italian operator and staff:

- Systematic omissions in the operational work
- Design not in accordance with regulatory requirements
- Managers with insufficient communication skills and knowledge of the Norwegian standards
- Cultural differences
- Repeated problems with the Italian management
- Poor work environment
- Discrimination of the local staff
- Incorporation and disturbance in daily operation from the operator company

5.2.4 Reflection

Overall, the project experienced cost overrun exceeding 62% and a time delay of approximately 3 years. In retrospect, the technical complexity of the FPSO and the shipyard's lack of experience with Norwegian requirements indicates that the cost estimate was optimistic.

It is the MPE's job to thoroughly consider the PDO submissions and either reject or accept. Because project such as Goliat is approved, it is according to *Professor Gudmestad* reason to question the competency within the MPE to fully understand the technical complexity that entails these major projects. However, it is still important to note that the operator is the responsible part for delivering a thoroughly planned PDO, and ultimately, the MPE often have to trust that the work behind development of PDO is sufficient.

Although the project suffered a troubled start with delays and cost overruns, the Goliat project can still become an attractive investment. The field's lifetime is approximately 15 years, and the future of the oil price will affect the profitability largely. Since production of the oil field started in March 2016, the project has already provided great economic value for the society. During implementation, spin-off effects from the project has caused considerable wealth to contractors in Northern Norway. Contracts worth more than NOK 20 billion has created employment for thousands of workers. The following sectors has experienced a significant effect [24].

- Industry
- Employment
- Education, training and research
- Contingency planning and oil spill protection
- Culture

The shipyard in Ulsan is of enormous size and operated with multiple constructions projects running in parallel to the Goliat project. This was reported as a significant delay factor. This suggest there was high competition for attention from other projects. From Hyundai's perspective, Norwegian projects would therefore only account for a small portion of the total business portfolio. The shipyard had already a developed a system to ensure lean efficient production, which points towards an insufficient incentive for adapting to abnormally high requirements for Norwegian projects.

With regards to the major design- and technological complexity that entailed construction of the FPSO, it is logical that one must anticipate complications and change orders when such projects are constructed at a shipyard in Korea. The cultures are widely different, with substantial differences in the legal requirements of quality and HSE. The Norwegian culture is a lot more flat than the Korean. Change orders require interdisciplinary problem solving and informal work groups, which suggest that change orders can be easier for Norwegian contractors to execute rather than Korean. Before deciding on a project concept, it is important that the contract strategy reflect the many uncertainty elements in the project. As observed in the Goliat project, this means risk factors such as communication, culture, influence and technical capability.

5.3 Valhall redevelopment

5.3.1 Field description, history & re-development

The Valhall field is located in the southern part of the NCS. The oil field was discovered in 1975 and started producing in 1982. The first development consisted of a drilling platform, processing platform and a living quarters platform, and subsequently a wellhead platform and a water injection platform.

The redevelopment was initiated due to expiry of design lifetime of the existing field centre. The application for the redevelopment and operation was submitted on 22nd of March 2007 and approved 25th of May the same year. In order to redevelop the Valhall field, installation of a new process field was required. Moreover, modification on the existing platforms for extended operations and adaptation to future production on the field. At the redevelopment phase, remaining reserves was estimated to 41.5 million Sm^3 oil, 6.9 billion Sm^3 and 2.2 million ton NGL (natural gas liquids). The licensees of the redevelopment are Hess Norge and BP (British Petroleum) Norge, with BP as the operator. Figure 5.5 shows the licensees' share of the project.

Licensees June 2013	
Hess Norge AS	64.05%
BP Norge AS	35.95%

Figure 5.5 Licensees' share of project Valhall Redevelopment [8].

The project was considered very technically complex and required high level engineering work as it included both new builds, modification to existing facilities, and new technology in connection with transition to electricity from shore. Moreover, these operations were carried out simultaneously with operations at existing facilities. The first oil was scheduled to November 2010, however, the realized date was January 2013, resulting in an implementation delay exceeding 2 years and 1 month. In addition to considerable delay, the redevelopment entailed substantial cost overruns.

5.3.2 Project experience & cost development

In November 2006, prior to PDO submission, the production facility and living quarters platform was hit by a powerful wave which caused considerable damage. The operator decided after the incident to rush the development. The development was therefore schedule-driven and few resources and little time was put into the early phase of the project. It was discovered late in the detail-engineering phase that dimensions and weight of the new platform was significantly underestimated. After the discovery, a lot more resources and time was required for hook up and commissioning phase. Another sign of weak early phase work was the significant high number of change orders during implementation.

Furthermore, an updated reservoir review from 2006 discovered that the field was significantly smaller than first estimated. Since the development already was designed for a production period of 40 years, the utilized material quality was better and more expensive than what was required. However, the operator determined it was too late and rushed the project. After considering the reservoir review, it was determined a larger need for wells than what was determined in the PDO. Further, the general costs associated with drilling and completion of each well was higher than assumed.

Many equipment packages included flaws and inadequacies even though they came from experienced equipment suppliers. This issue was blamed on poor follow-up of the sub-contractors. Since the issue of the equipment packages was discovered at such a late stage, it caused correction work and detailed mechanical completion that all together affected the commissioning and start-up.

The PDO did not anticipate the challenges that followed the simultaneous work of offshore hook up, commissioning and operation of existing facilities. The simultaneous operations made all modification work on existing facilities more complicated. The limited bed capacity was a continuous discussion between project and operations management, and the weather-sensitive flotel that was not permanently anchored contributed to further problems. As a result, completion was delayed.

The supplier responsible for the living quarters module went bankrupt and could not complete the construction, which meant that BP had to go in and secure operations until completion. This action required more costs and resources. The market was tighter than assumed in the PDO, which resulted in scarcity of expertise among engineers, which was especially important in certain areas. A combination of tight market and special design requirements was considered a major reason for cost increase, quality issues and delays.

In regards of HSE, Petroleum Safety Authority (PSA) reported serious deviations in an audit associated with the licensees' internal decision- and documentation system. The audit revealed that licensee Hess did not know the basis for their own risk management system. Moreover, their current documentation system was not able to trace back old documents, which was a crucial error and a clear deviation from the HSE regulations [31].

Table 5.3 shows cost development of the PDO to the realized cost after completion in 2013. 40% of the total budget was covered by contracts before the PDO was submitted. The numbers are received from the operator, BP Norge.

Table 5.3 Planned and realized cost development for project Valhall redevelopment [8].

	MNOK (2012) PDO	**MNOK (2012) Completion (May 2013)**	**MNOK (2012) Change from PDO**	**% Change from PDO**
Project owners	2 098	2 101	3	0%
Ready for Operations	807	1 000	193	24%
Topsides	5 322	7 691	2 369	45%
Structure	620	689	69	11%
Power from Shore	1 841	2 067	226	12%
Living Quarters	833	1 903	1 070	128%
Safety Automation Systems	440	618	178	40%
Transport and installations	584	552	-32	-5%
Subsea pipelines	642	1 262	620	97%
Brownfield Modifications	1 482	3 137	1 655	112%
Hook Up and Commissioning	720	5 503	4 783	664%
Project Handover		567	567	
Un-Allocated provision		-2 205	-2 205	
TOTAL	15 391	24 887	9 496	62%
Well costs Valhall Redevelopment	3 277	13 986	10 709	327%

5.3.3 Reflection

Insufficient time was spent in the early phase. The project was time-driven from the start and it had major consequences. The operator lacked a sufficient internal decision system with quality assurance and maturing of projects up to a final project approval. The updated weight and dimensions and the reservoir information should have been discovered earlier so that a new design review could have been conducted. This would have avoided major complications related to changes in topsides size, weight, quality requirements for design lifetime, the amount of change orders and offshore hook up. The extra costs that followed the project resulted in an amplification by the high cost level on a macro-economic scale.

Insufficient follow-up of quality in large equipment packages entailed rework. The operator should have supervised the fabrication of the large equipment packages and the work from sub-suppliers. The complexity of modification work, hook up, completion and start-up of new facilities while simultaneously operating existing facilities entailed many challenges and was significantly underestimated. The bed capacity was also underestimated.

Valhall redevelopment have developed a slight spin-off effects on the society in terms of employment, mainly related to business activities (engineering services), but also transportation and engineering industry on a national level [32].

5.4 E6 Langslett-Sørkjosen

5.4.1 Project description & history

In the transportation sector, "E6 Langslett-Sørkjosen" is a tunnel construction project located at Sørkjosfjellet in Nordreisa municipality. It is the main highway connection through Troms in South-north direction. Today's road runs across the Sørkjos mountain, which is characterized with steep slopes (9% inclination), sharp turns and therefore recommendation for low speed. The stretch has traditionally been a bottleneck, especially for heavy transport and transit. The location of the planned tunnel is illustrated in Figure 5.6.

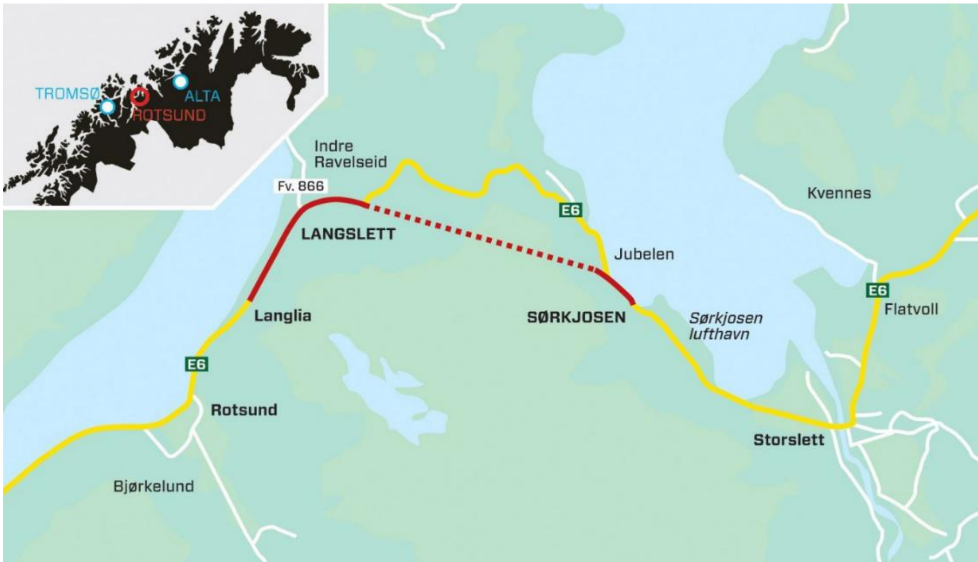

Figure 5.6 The red line illustrates the location for the planned tunnel [25].

The Norwegian Public Roads Administration (NPRA) appointed Metier AS to perform external quality assurance (EQA) on the project. Metier's purpose is to assist clients in implementing successful projects through a large portfolio of services, training, certifications and systems [27].

Metier AS concluded that the project organization (with Gudmund Løvli as project manager) held extensive expertise and broad experience from similar road- and tunnel projects [26]. In addition to approving the project team's expertise, the company used internal expertise to give the following recommendation to approach the project. Table 5.4 shows the recommendation for project approach.

Table 5.4 Recommendation for project approach

	Recommendation
Contract strategy	• Performing and documenting a market analysis will assist basis for decision on contract strategy • With regards to current market conditions, suggested contract term are to perform a builder controlled project, with one main contractor
Uncertainty elements	• Market uncertainty • Relationship to contractor, project management & implementation skills
Mitigating actions	• Explore the market and adapt contract strategy • Good interaction with contractor, extract lessons from past projects
Schedule and cost	• Start construction at 2013/2014 and end 2016 • Estimated cost: 860 MNOK. Recommended budget: 920 MNOK

The Norwegian Public Road Administration (NPRA) decided to hire the Spanish entrepreneur Obras Subterraneas (OSSA) to construct the tunnel project in March 2015. Five months later, the contract with the Spanish entrepreneur was terminated due to significant lack of progress and multiple contractual breaches of HSE regulations.

After meeting with project leader Gudmund Løvli, "*Teknisk ukeblad*" gained access to the details around the conflict between NPRA and OSSA [25]. Project leader Løvli was hired by the NPRA to assist and perform project follow-up on the Spanish contractor.

5.4.2 Project experience

The Spanish contractor offered a significantly lower project cost compared to number two in tendering. OSSA submitted many reference projects, including one from Oslo. They claimed to have experience in performing projects in cold areas. Their reference list showed mainly projects in Spain, South America and Asia, whereas most reference projects were confidential. It was challenging to get proper insight in these projects. But overall, the Løvli seemed satisfied and optimistic about the Spanish contractor.

The responsible in NPRA claimed in retrospect that they got a bad feeling early on. The project team emphasized to start implementation early considering they were situated north of the Arctic Circle and worried about the dark season. OSSA spent considerably much time on contract signing. Further, there was significant delay before approval of the crew was in order. Moreover, the same trend was observed when training the workers and servicing equipment. The implementation finally began in November, although their initial agreement for startup was scheduled in September.

There was substantial deficiencies on the equipment; for example, the excavator was not nearly as technical as Norwegian construction workers are used to. Furthermore, compared to standards, the cycle between each explosive ointment was long, and they were not able to keep up with the planned progress in the tunnel. The Norwegian standard was normally 100m progress per week, while OSSA spent 5 months to reach 450m. The contractor struggled to solidify their concrete that was sprayed up, which for safety reasons were very important.

It is common to use lasers connected to computer systems when operating the tunnels in the right direction. The entrepreneurs were not able to operate the computer equipment and therefore used a navigation method that involved following cords from the overhang. The method was proved insufficient and caused the navigation to go off course several times. Furthermore, tunnel bolts began to pop out.

In regards of HSE, there was several dangerous events including use and storage of explosives and working under unsecured conditions. The most shocking incident was reporting of open flames in the tent where explosives were stored. Furthermore, explosive ointments, performed by unauthorized personnel, went off regularly without any warning ahead. The NPRA observed multiple breaches of contractual regulations.

The project manager named cultural differences as a problem. In the execution phase, many workers desired to learn the Norwegian way of conducting tunnel construction. OSSA competed on equal ground with Scandinavian contractors such as Skanska and Veidekke. According to European Economic Area (EEA) agreement, all contractors have equal conditions for competition and compliance of rules. This means setting the same requirements for quality and standards as Scandinavian contractors.

Communication problems was frequently observed between the parts. In tendering, it was required by the NPRA that the contractor knew the Norwegian language. The contractor hired a translator but whom did not have technical background. Google translate was also used as a communication tool. The communication problems led to many incorrect translations and misinterpretations. This was not a problem at the project office, but in the facility, it could impose a safety risk. OSSA eventually hired Swedish subcontractors to contribute to the work. According to the project leader, this led to significant improvement in quality and communication.

5.4.3 Lessons learned

Deficient prequalification of the Spanish contractor was considered main lesson. The past reference projects of the contractor should be more investigated. This would make it easier to get insight of the company and find the full truth of their past projects. Next time NPRA will spend more time on prequalification and request a larger budget. However, at the same time, it is important to respect the EEA agreement.

5.4.4 Reflection

The traditional highway around mountain Sørkjos was considered dangerous and has caused multiple traffic accidents the past years. Successful construction of the tunnel would provide better traffic flow, increased traffic safety and reduce transport distances between Troms and Finnmark. It was reported that traditionally, heavy vehicles have often required assistance when crossing the mountain. This issue would have been eliminated. Further, opening of the tunnel would provide a safer and more predictable access for markets. On the contrary, the outcome has resulted in more than a year delay for the project. In addition, most of the work by the Spanish entrepreneur is not useful for further work.

In hindsight, it is clear that the contractor was simply not qualified for a project this complex and should not have been considered as a suitable candidate in the first place. The project failed due to a combination of technical inadequacy, underestimated project complexity, communication problems, cultural differences, HSE related issues and lack of compliance with Norwegian standards for quality.

There is reason to critically assess the quality work in prequalification. Thorough investigation would have revealed the inadequacy in technology and limited linguistic skills within the Spanish entrepreneur. They were able to list a broad variety of references, but few of these were detailed and many labeled as confidential. There is reason to believe that some of these projects were covered up and labeled “confidential” in order to hide troubled projects. Since the reference list mostly showed projects from other continents, it would be highly necessary to compare the typical differences in complexity and technology of these projects. Tendering stated a requirement towards the Norwegian language. However, given the fact that the contractor brought translators without technical background, and used Google translate, it suggests that NPRA never specified what tools and skills towards communication was required.

Subsequent to the termination of contract, OSSA filed a lawsuit against NPRA, for breach of contract. The entrepreneur also stated a lot of the accusations written in *Teknisk ukeblad* were wrong [25]. It is worth noting that the information from *Teknisk ukeblad* is based on the subjective opinion of the project leader, who is a representative for, and employee of NRPA.

5.5 Summary of study – brief overview

Table 5.5 presents a brief overview of the project results. If the boxes are left blank, it means there the information was not applicable or not present.

Table 5.5 Comparison of studied projects

	Yme	**Goliat**	**Valhall Re-development**	**E6 Langslett-Sørkjosen**
Overview				
Completed project		✓	✓	
Estimated cost in millions NOK	4894	30942	25100	900
Realized cost in millions NOK	14114	50000>	50000>	N/A
Cost overrun	188%	62%	100%	N/A
Schedule delay	3years >	3years >	2years >	5 months >
Main problem	MOPU contract format	FPSO re-work	Technical complexity	Unqualified contractor
Contract format	EPCIC	EPC	Traditional	Total contract
Contractor's nationality	South-Korea	United Arab Emirates	Mixed	Spanish
Spin-off effects		✓	✓	
Deficiency/problems				
High activity level		✓	✓	
Insufficient planning phase	✓		✓	
Prequalification	✓	✓	✓	✓
Aggressive schedules	✓	✓	✓	
Technic complexity	✓	✓	✓	✓

	Yme	**Goliat**	**Valhall**	**E6 Langslett-Sørkjosen**
Norwegian standards for quality	✓	✓		✓
Re-work	✓	✓	✓	✓
Cultural	✓	✓		✓
Communication	✓	✓		✓
HSE	✓	✓	✓	✓

5.6 Summary of study - detailed overview

Table 5.6 presents a further detailed overview of the project results.

Table 5.6 Detailed comparison of studied projects

	Yme	**Goliat**	**Valhall Re-development**	**E6 Langslett-Sørkjosen**
Overview				
Project completed		✓	✓	
Estimated cost in millions (NOK)	4894	30942	25100	900
Realized cost in millions (NOK)	14114	50000>	50000>	N/A
Cost overrun %	188	62	100	N/A
Schedule delay	3years >	3years >	2years >	5 months >
Main problem	MOPU contract prevented input/influence from operator	Technically complex. FPSO re-work. High activity level	Technically complex. High activity level	Technical inadequacy. communication
Contract format	EPCIC	EPC	Traditional	Total contract
Contractor's nationality	South-Korea	United Arab Emirates	Mixed	Spanish
Spin-off effects		✓	✓	
Deficiency/problems				
High activity level		Market turned during implementation. Increased cost profile	Tighter market. Scarcity of expertise engineers	

	Yme	**Goliat**	**Valhall Re-development**	**E6 Langslett-Sørkjosen**
Poor planning phase	FEED phase. Internal decision system		Detail engineering. Internal decision system	
Prequalification of contractor	Qualified, but no experience with NORSOK	Qualified, but no experience with NORSOK	Qualified	Qualified (but unknown technical competency)
Aggressive schedules	Yes, SBM wanted to complete project to start collecting rental income	Yes, optimistic time frame	Yes, facility damaged by wave, hence rushed development	No, but OSSA failed to meet Norwegian excavation progress
Technical complexity	No, SBM was founder of FPSOs	Yes, Special designed FPSO, pioneering work	Yes, new builds simultaneous with existing builds	Yes, contractor was inadequate technically
Norwegian requirements for quality	Yes, struggled adapting to high standards	Yes, struggled adapting to high standards		Yes, struggled to adapt to high standards
Re-work	Yes, defects and change orders	Yes, defects and change orders	Yes, defects and change orders	Yes, defects and change orders
Cultural challenges	Yes, Mixed nationalities	Yes, Norwegian, Italian & Korean		Yes, Norwegian, Spanish
Communication problems	Yes, not willing to communicate due to contract	Yes, culture crashes inhibited change orders		Yes, linguistic inadequacies

	format ('lease')			
	Yme	**Goliat**	**Vallhall redevelopment**	**E6 Langslett-Sørkjosen**
HSE breach	Multiple breach of regulations. Platform evacuated	Multiple deaths at shipyard and further issues on field	Deviations in documentation & risk management system	Multiple breaches of regulations

6 Recommendation

6.1 General lessons learned

Based on this study of projects, there are common aspects that can be learned from in future developments.

Allocate resources effectively in early project phase

Thorough and satisfactory work in early engineering phase is a key aspect for a successful implementation. In this context, this means all work prior to implementation startup. In the reviewed projects, far too ambitious implementation schedules revealed shortcomings especially in the early project phase. Without a good internal decision program for maturing projects in an early phase, the insufficient level of engineering will create an unbiased cost estimation. Deficiencies and flaws in the early phase transmits through the project development, which in this study was clearly observed through the substantial amount for change orders. Re-work and changes resulted in major overruns and delays. For future projects, thorough early phase planning must be basis for allocating resources more effectively.

Ensuring good interaction with contractor and other sub-contractors

In the majority of the studied projects, complications were linked to relationship between operator and contractors. The root of the problems were often poor communication. Diversities of national legal requirements created further friction between the parts. The study suggest operating with multiple cultures often can be associated with more complications towards requirements for quality, HSE, communication and the ability to perform change orders. If there is substantial culture gap between the parts, this risk must be reflected in the selected contract strategy. In other words, it is important to have a contract strategy that allows for close follow-up, strong influence on development solutions and a superb mutual understanding between the parts.

Ensuring compliance of Norwegian requirements for quality & HSE

In 3 out of 4 the projects reviewed, basis for major complications was insufficient compliance with the Norwegian requirements for standards. However, it is important to note that the majority of studied projects involved special detail design, several of which was considered pioneering work. Regardless of design requirements, an underestimated process is ensuring that the contractors has the capability to deliver technical content according to Norwegian requirements. Different precaution actions can be improved, such as thoroughly selecting contract strategy, conducting courses, seminars on Norwegian requirements for standards and incentivizing contractors through rewards/penalties for hitting or missing quality demands.

Select a contract strategy that ensures participation, follow-up, influence and transparency

The review showed that the operator relied too much on, and without necessary verification, that the contractor and their subcontractors would deliver according to contract specifications. The study showed that large contracts handed to foreign contractors have appeared particularly cheap in tendering, but proved to be associated with compromised quality, extra rework and the accruing costs.

The study revealed that some of the contracts created a power distribution that inhibited the ability to perform direct follow-up and actively participate in decision-making solutions. This risk especially followed larger contracts that created boundaries between the parts. Therefore, it is important for the operator to take on enough contract responsibility to ensure successful deliveries.

The contract strategy must ensure quality and a cost-effective progress, including the operator's opportunity for follow-up, verification of work, transparency and influence on corrective measures along the way. It is important that the contract strategy reflects the main risk elements in the project.

Adapt the contract strategy to the level of risk and gains with right incentives

Several of the projects introduced challenging technology and design elements that involved over the average risk. Under these circumstances, choosing correct contract strategy are crucial to ensure participation and influence in development solutions. Project with high risk level should therefore avoid the ‘lease’ concept and prioritize a ‘build to own’. Moreover, the operator might want to consider taking on more responsibility in projects considered over the average risk, perhaps by using more separate contracts (NF) rather than larger EPC-contracts (NTK).

Conversely, projects with a thoroughly planned early phase and a project that consists of known technology elements will be more suited for a total contract. In such situations, an operator can to a larger extent calculate accurate cost estimation and trust the contractor and subcontractors to deliver according to contract stipulations.

The contractors’ have with the traditional contract regime exploited possibilities to earn more hours or use higher quantity or quality of material than necessary. It is therefore important in uncertain and time-driven projects to have a contract strategy that incentivizes contractors to keep costs low even if possibilities to earn extra money arise through variation orders. Correct incentives can be applied along the process, for example rewards/penalties for hitting or missing determined performance targets.

6.2 Strategic options for performance improvement

In the last few years, market fluctuations have entailed limited options for Norwegian players to survive the tough market. The industry needs to develop new ways of thinking that can better address the financial and competitive challenges associated with structural changes in the market and low oil price. Based on the performed study and extracted lessons, three options are logical responses for countering the challenges players on the NCS are facing.

Strategic alliance

One option is creating a strategic alliance, which is an integration of oil company and contractor organization. Simply put, the purpose of an alliance is to achieve more benefits than if each company operated separately. All rewards and risks are shared among the partners. By combining resources and capabilities, the collaboration model can potentially lead to a strengthened competitive positioning, shielding themselves from market uncertainty. The relationship facilitates higher objective sharing and transparency between the partners. The partners can collaborate from an early phase of the project, where knowledge and experience can be transmitted from one project to the next. This can facilitate a stable work environment and introduce flexibility in operations. Because the alliances contains more internal capabilities and resources, there is less need for sourcing work. However, a significant draw back with this model is that the parts are ‘locked’ together, meaning the operator cannot choose an outside contractor simply because their prices are lower. Moreover, if integration fails, the project might spin out of control, causing harm to the reputations of the partners involved. Furthermore, since the partners are united as one, they also share liabilities.

Strategic alliances are specifically relevant in current market conditions on the NCS. From the operator’s perspective, the low oil price and reduced margins and high asset availability is an opportunity to negotiate better day rates. From the contractor’s perspective, securing financial obligations and debt on assets is crucial in a low price environment where opportunities are few.

Strategic alliances are more deployed in other industry sectors compared to the O&G industry. Sectors such as transportation, aerospace and automotive also entail large-scale projects with tough market competition. These sectors have through alliances achieved innovative technologies and increased productivity. For these reasons, the recent structural changes in the market have made oil companies more opened for the opportunity of creating alliances.

If done right, the collaboration model can provide mutual benefits and can be an opportunity to address the financial and competitive challenges arising in today’s O&G industry.

Waste reduction to go 'lean'

A second approach is pursuing the concept of 'lean' project development and implementation. A modern focus is finding out how the oil- and service supplier companies together can find improvements and maximize efficiency. This concept is broadly observed by the substantial downsizing within Norwegian O&G and OFS companies.

In the company's perspective, downsizing can contribute to more efficiency, but it will also cause loss of expertise from the downsized staff. The 'lean' concept is further utilized in the development and implementation where the major players have an objective of drastically reducing costs in all phases of the project, (engineering, procurement, construction, installation). The benefits of such measures is reduced waste (time, material), costs, improved efficiency, and can also help support HSE.

However, it can be difficult to achieve 'lean' development and implementation, because it requires close interaction and dependency between the operator- and service supply companies. The traditional contract structure do not incentivize each other to help the other part reducing costs or make improvements. Therefore, this can be a restriction on optimizing waste reduction to go 'lean'. Furthermore, a risk is overusing the concept, when the solution becomes problem, reducing too much waste until it compromises production and/or quality. It is therefore important to balance the waste reduction while simultaneously providing sufficient quality and production [46].

Risk-gain sharing agreements & Performance based contracts

A third option is applying risk-gain sharing (incentive) contracts and performance based contracts (PBC) on a larger scale. The majority of spend in contracts are structured in ways that do not compensate suppliers based on performance. Incentive and performance based contracts in the O&G industry only account for approximately 15% of the current spend. The distribution is as follows: Cost reimbursable (36%), Variable (22%), Fixed (18%), Incentive (15%), Other (5%), Mixed (3%) and Cost reimbursable capped (2%) [1].

The contract structure in risk-gain sharing agreements is based on balancing risk vs. reward. The parts' share gains based on the contractor's ability to cut costs, delivery times and improve quality or technical performance. Various types of incentives can include additional bonus payments, value gain sharing or price penalty for underperformance (downtime etc.). An example of such agreement can be cost-reimbursable contract with a predetermined target cost, scaling the contractor's profit directly based on the actual cost, or where the final price is adjusted based on the contractor's ability to fulfil the incentive objectives.

Moreover, companies often have different opinions of handing out bonus payments. On one side, workers can be incentivized to perform work thoroughly the first time and therefore avoid downtime to the project. On the other hand, the focus on reaching deadlines can be so great that shortcuts are undertaken. This can again lead to compromised quality and safety. Therefore, it would be challenging to maintain quality, performance and HSE demands while focusing on bonuses at the same time [36].

Performance Based Contracts (PBC) is about buying performance. It stands out from the traditional contracts with a transactional good or service. The concept is based on developing a set of performance targets where the payment is directly related to these targets. PBC shift risk and corresponding reward the contractor who can best improve performance over a specified time. PBC are not extensively used in the O&G industry, because it is challenging to convert this concept in complex offshore projects [42].

However, the main challenge with such contracts are applying measureable parameters. It can seem complex to implement because the number of variables that needs to be defined for each contract model increases for incentives/PBC. Because of this, it is important to find the balance between complexity and implement ability. Wrapping the head around such agreements can seem complex, and it can be argued whether such contracts might be more suited for growth in a collaborative environment [36].

However, incentive/PBC contracts can drive competition between suppliers, finally rewarding the suppliers based on their performance. This contributes to focusing more on value delivery, rather than only cost. Introducing more of these contracts can provide a major opportunity for Norwegian players to strengthen their competitive positioning. Table 6.1 summarizes and presents the advantages and disadvantages of the strategic options.

Table 6.1 Advantages and disadvantages of various strategic options

Options	**+Advantages (benefits)**	**-Disadvantages (risks)**
Strategic Alliance	+ Pooled resources + Strengthened capabilities + Early contractor influence (concepts, costs, solutions) + Transfer of experience + Stable work environment + Less sourcing + Flexibility in operations	- Partners 'locked' together - Integration/collaboration - Lack of control - Unequal benefits - Merged reputations - Shared liabilities
Waste reduction to go 'Lean'	+ Reduced waste (time, material) + Reduced costs + Improved efficiency + Can support safety	- Lost expertise due to potential downsizing - Difficult to achieve 'lean' - Overuse can compromise production/quality - Balancing waste reduction & production/quality
Risk-gain sharing agreements & PBC	+ Contractor motivation + Support cost cuts + Continuous improvement + Time/material elimination	- Requires clear mechanisms for sharing risk/reward - Difficult to implement - Balancing complexity and implement ability

The three strategic options entail advantages and disadvantages that must be taken into account when selecting an approach for adapting the market situation. Based on the study findings, the formation of strategic alliances stands out as a beneficial approach to strengthen competitive positioning. In addition, study findings suggest pursuing the 'lean' concept, and implementing risk-gain sharing agreements & PBC might be more suited in the environment of a strategic alliance.

6.3 General/common performance variables related to Contracts

Across the different industry sectors, common basis within contracts is the framework that consists of obligations, opportunities and constraints of which the involved parts are subjected to. Decisions within these performance variables will have an effect on the risks and values that will influence the outcome of the project. A common goal for projects is to minimize the risk involved and maximize the value. Figure 6.1 show the general/common performance variables.

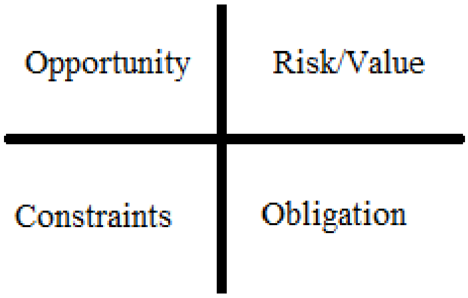

Figure 6.1 General/common performance variables in a project

Obligations:

Obligations are promises that the parts are bound or obliged to follow. An obligation in project management context can roughly be described as ensuring the deliveries accommodates with the terms of the agreement. In further detail, obligations can be ensuring adherence of reporting and milestone obligations, compliance obligations, such as publications and confidentiality, ensuring that the project funds are spent in accordance to the contract stipulations, providing proper insurance for the project and to disclose potential conflicts of interests in accordance to the agreement.

Opportunities:

Opportunities that arise during project implementation are very important to recognize and capitalize on. Avoiding lost opportunities is basis for maximizing the efficiency and achieving project success. Modern day projects are increasing in size and complexity, and often involve many different cultures. It is important to account for cultural boundaries and differences that may occur as an obstacle in projects. Ensuring mutual understanding and good communication is a vital factor for successful implementation. A main source for recognizing opportunities is through experience and lessons learned. For an example, opportunities can arise out of staff feedback regarding process optimization and HSE related issues. However, it is important to note that some opportunities can be difficult to recognize in today's market situation due to the substantial high focus on budgets and spending.

Constraints:

A constraint, in project management, is any restrictions that defines a project's limitations; the scope, for example, is a limit of what the project is expected to accomplish. The three most significant project constraints are schedule, cost and scope. The scope involves the specific goals, tasks, deliverables that define the boundaries of the project. The schedule specifies the timeline according to which those components will be delivered, including final deadline for completion. Example of constraints on resources are types, amounts, access of required resources, etc., while resources are staff, material, facilities, machinery, etc.

Risks & values:

All the decisions made along the project within the performance variables will in the end make up the total risks and values in a project. The total risks and values defines the level of success for the specific project. An opportunity can be a risk, but it could also be a value. The same accounts for all the other performance variables involved. In order to achieve an efficient and successful project performance, decisions must be made on basis of increasing value and reducing risk. Understanding and capitalizing on the performance variables is vital for minimizing risk and maximizing value in a project [37-40].

6.4 Attributes/Critical features of performance improvement under Contractual conditions

Table 6.2 presents attributes related to performance improvement under Contractual conditions, developed in a brainstorm session at a HUB meeting with CIAM at the University of Stavanger.

Table 6.2 Attributes/Critical features of performance improvement under Contractual conditions [17].

Attributes	**Description**
Income	Money a company receives in return for providing a service or good through investing capital
Maximize production	Using existing assets to maximize production is an obligation because it provides major economic value for a project
Different objectives of contractors	Contrasting objectives of parts involved in a project can be a constraint on maximizing efficiency and total economic value of the project
Opportunities to improve/lost opportunities	Recognizing and capitalizing on arising opportunities create more efficiency and value for a project. Conversely, lost opportunities can provide loss of value
Measureable content	Precise and correct parameters/metrics in a process is required to keep track and measure the content
Legal requirements – local and international	Legal requirements in a project applies to the specific activities involved, and can be constrained by the distinctive requirements for each nationalities
Changing conditions	Changing conditions can force companies to consider new options for adapting the market situation. Changed conditions after contract rewarding must alter the original terms and conditions
Technical content	The technical scope and specifications of the project covered by the contracts
Safety vs Quality	Safety and quality are interdependent, meaning if a project result in low quality, it also introduces a risk exposure, and conversely

Performance scope vs Capacity/capabilities	Inadequate capacity/capabilities can impose a risk for realizing the expected performance scope
Attributes	**Description**
Stretched targets	It is obligated to push the performance beyond what previously has been achieved in order to achieve success
Bonus for better performance over base line	Compensating contractors based on performance can introduce more value to a project through cost cuts and performance improvement
Actual scope vs. Time	The actual scope can be constrained by the time limit. Can result from optimistic time schedules or poor efficiency
Negotiation Flexibility	Flexible negotiation decisions are crucial for making correct decisions that contribute to more value. Conversely, low flexibility in negotiation introduces a risk
Frame agreements	Contracting model where the client and contractor seek mutual benefits through collaborating from project to project. However, partners are 'locked' together, disallowing sourced work
Documentations	Documentations are used to gain control of critical processes that describes the use, operation, maintenance and design. Thorough documentation management processes reduces risk, coordinate deliverables from contractors etc.
Extended obligations / liabilities for extra compensations	The contract must specify and ensure liabilities in case of for extra compensations for clients
Function but not the product	Contractors prefer to work with a function that can be solved in a desired way, rather than delivering a product with predetermined specifications
Pre-conditions expected	Specific conditions demanded by the client that have to be fulfilled by the contractor to enter into an agreement
Multiple contractors 'Alliance'	Strategic alliance is a collaboration between the principal and agent organization(s), with the intention of together creating more value through pooling resources and sharing capabilities
Waste reduction to go 'lean'	Companies can increase efficiency by reducing waste, such as staff, material or resources
Rates in contracts	Compensation rates specified in contracts that can be either negotiable or non-negotiable
Lessons learnt / Benchmarking	Benchmarking measures internal performance and comparing to others performance, with the intention

	of finding out how their organization can achieve higher performance levels
Attributes	**Description**
Supplier selection and management	Selecting supplier involves more than scanning for price. Decisive factors are value for money, reliability, financial security, quality, service and communication
Competence for Performance	Delivering at the expected performance level require adequate competence from the contractor

6.5 Selected strategic approach

The study of projects and evaluation of strategic options suggests that a strategic alliance can bring major benefits compared to the traditional contract regime. Strategic positioning between operator and contractor organization can be mutually beneficial and a wise approach to strengthen the collected competitive positioning from players on the NCS.

6.5.1 Strategic alliance

A strategic alliance is a "business model", which integrates the oil company and contractor organization. The members involved in an alliance can be two or multiple partners, independent of geographical location, and will require cultural restructuring for all parts.

The purpose of forming an alliance is to join forces, align common objectives and achieve better performance and results than if the parts operated individually. Joining forces means shared investing, capabilities, resources, risks and rewards. If done right, results can be mutually beneficial and introduce more balance when working with new field developments. A long-term collaboration with shared risk can stimulate for innovation, cost savings, improve HSE and overall performance and operability by utilizing the parts shared capabilities and resources [41].

Integration has recently been observed between players on the NCS. Det Norske (has now become Aker BP), Aker Solution and Subsea 7 have formed an alliance they describe as "one for all, all for one" type of model. All parts in this collaboration share both risk and rewards. The collaboration combines the expertise from Aker BP's exploration and production, Aker Solution’s FEED and subsea systems and Subsea 7’s knowledge in EPCIC of subsea umbilical’s, risers and flowlines. The companies will establish an integrated project management team consisting of experts from each company. Historically, developments have been handled on a project-by-project basis, resulting in limiting reuse of technology and solutions. However, the objective for this alliance is to create continuity across development projects by applying lessons learned and reuse solutions that will cut costs, lower implementation time and support safety and quality [43].

Alliances are especially relevant in today’s increased cost profile and the marginable profits that entail project developments. Forming closer collaboration partnerships can create more value for both parts and be mutually beneficial. Because of the challenging situation that the O&G industry are facing, it is more important for operator and contractor to cooperate and find effective ways to cut costs and contribute to a more efficient approach.

An alliance is in the contractor’s perspective a way of sustaining a constant stream of work portfolio in order to stay in business. For contractors, securing financial obligations and debt on assets are crucial in a low price environment where opportunities are few. For operators, the low oil price and reduced margins and high asset availability is an opportunity to negotiate better day rates. This form of strategic positioning is not necessarily as beneficial when oil price is high. In a high oil price environment, with a consequently high project development activity and limited asset availability, the contractor is in a position with strong leverage for contract negotiation. These interest factors and the cyclic nature of the industry sets the background for developing mutual interest alliance contracts.

The relationship facilitates higher degree of congruence (objective sharing) and mutual trust between the parts. Moreover, the alliance relationship supports growth for developing incentive-based input during contract negotiation. However, a significant draw back with this agreement is that it the parts are ‘locked’ with each other, which constrains offers from other contractors.

6.5.2 Performance improvement framework

The purpose of collaborations between operator- and service supplier companies is to facilitate achievement of common goals and providing benefits for all network members. However, such collaborations can also be challenging. Three network conditions can be considered basis for accomplishing network effectiveness; capability matching, objective alignment and partnership health [44]. Table 6.3 explains the definitions of the various network conditions.

Table 6.3 Definitions of network conditions [44].

Network conditions	**Definitions**
Capability matching	Describes the ability to deploy resources and abilities of organizations for collaborative purposes
Objective Alignment	Describes the match between organizations individual objectives and interests within a manufacturing network
Partnership health	An indicator of the mutual relationship between partners within a manufacturing network

As illustrated in Figure 6.2, the combination of these three categories of network conditions suggest a specific level of network effectiveness.

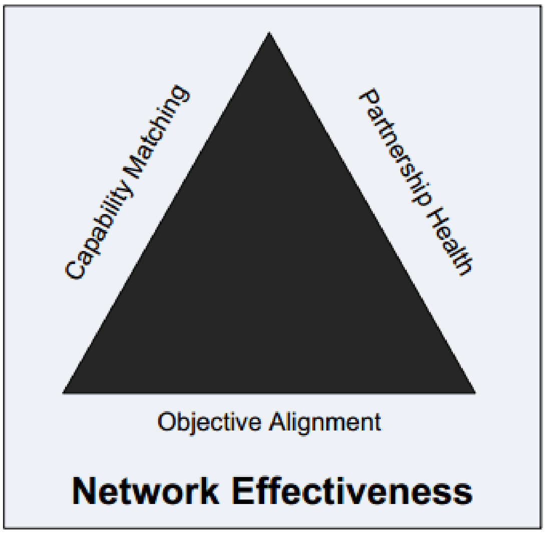

Figure 6.2 Illustrates network effectiveness based on Partnership health, Capability matching and Objective alignment [44].

When two or multiple organizations integrate and form a strategic alliance, it changes the performance variables associated with the traditional contract regime, influencing the risks and values involved. As illustrated in Table 6.4, the reviewed attributes for performance improvement can be sorted in the following categorization of performance variables:

Table 6.4 Categorization of attributes for performance improvement [17].

Opportunity	Risk/Value
• Waste reduction go 'lean' • Frame agreements • Multiple contractors «alliance» • Lessons learned/benchmarking • Competence for performance	• Opportunities to improve • Negotiation flexibility • Function but not the product • Bonus for performance over base line • Changing conditions • Rates in contracts
Constraint	**Obligation**
• Different objectives of contractors • Legal requirements • Actual scope vs. time • Pre-conditions expected • Supplier selection and management	• Maximize production • Safety vs. Quality • Measureable content • Technical content • Documentations • Stretched targets

Opportunities. Recognizing and capitalizing on opportunities can create value and strengthen the competitive positioning for players on the NCS. Various options are waste reduction to go 'lean', creating frame agreement, strategic alliance and benchmarking results.

Constraints. Pursuing a strategic alliance can have a major impacts on the constraints observed with the traditional contract regime. For example, a strategic alliance aligns the partners' objectives through pursuing common goals and rewards, providing growth for increased project life cycle value. Moreover, in long-term alliances, knowledge and experience transfer from project to project can improve compliance with the different legal requirements between the nationalities.

Obligations. The obligations within a project can be influenced through a strategic alliance. For example, maximize production is an obligation for the project and will provide major economic value the licensees. If done right, a strategic alliance offers close collaboration, shared capabilities and collected decision-making that can contribute to less delay, hence facilitating maximized production. Alliances can also improve safety management over time due to experience and knowledge transfer between projects, the reuse of technology and solutions, and a stable work environment.

Risk/value. The attributes for performance based contracts introduces multiple shifts in risk and values associated with strategic alliances compared to the traditional relationship. The traditional contractual relationship have constrained the negotiation flexibility. Strategic alliances provide value by introducing a flexible work environment, introducing contractor's earlier in processes and letting them work with a function rather than a product, facilitating optimized concepts, solutions and value growth. Bonuses for performance over base line entails more incentives for contractors to pursue cost cuts, improve efficiency and reach objectives.

6.5.3 Some selected challenging attributes for performance improvement

- <u>Obligations</u>

Maximize production – obligation

Maximizing the production is an obligation and priority for oil companies, because producing at the earliest stage possible will provide major economic value for the licensees. The study revealed substantial delay in all of the projects, causing first oil/completion date to be postponed, which further led to detrimental impacts to the projects economic value. Lessons extracted from the study suggested different objectives between the parts was basis for many project complications. The review showed contractors that implemented individual decisions, without input from the operator. In order to maximize production, companies must reduce the complications that eventually lead to project delay.

By reaching higher level of congruence, the parts can together have a focus on increasing life cycle value. This can make the contractor not only focusing on own cost reductions, but make decisions based on the economic value of the project.

Compared to the traditional contract regime, strategic alliances can facilitate for maximized production because the collaboration model can address many of the challenges observed in the study. The collaboration aligns the objectives of the partners involved by sharing strategy and rewards. A strategic alliance involves contractors early in the project, providing a collected decision-making system that can provide growth for optimized solutions, production and achieve larger economic value for the project.

These factors contribute to an overall better performance, reducing the risk of production delay and creating more value by implementing many benefits from the collaboration.

Safety vs Quality – Obligation/risk

Safety and quality are interdependent, meaning one cannot have safety with quality, and conversely. Ensuring safety and quality is an obligation and first priority in offshore field developments. Deviation and failure in the system quality can result in death, economic and environmental damages. Several examples extracted from the review showed significant deviation from Norwegian requirements for standards and HSE, where most common deviations involved design flaws, material failures and human factors.

On the Yme project, the personnel on the platform had to evacuate due to cracks in the formation structure. On the Korean shipyard where Goliat's FPSO was built, fourteen workers had lost their lives that year, which of them three was from the Goliat project. In the Valhall redevelopment project, the PSA (Petroleum Safety Authority Norway) discovered significant deviations in the operator's internal risk management system. On project E6 Langslett-Sørkjosen, dangerous incidents were reported regarding open flames close to explosives and unauthorized ointment explosions.

Overall, the review suggests that projects operating with different cultures and requirements for HSE introduces more uncertainty towards quality and safe implementation.

A strategic alliance uses an integrated team that have shared standards, practical specifications and operations and tools. These repeatable capabilities can be transmitted from one project to the next. Reusing technology and solutions in a stable work environment can provide growth for continuous improvements. Moreover, earlier contractor participation means the contractor is able to influence concept and decisions, which can optimize solutions. All these factors are benefits of the strategic alliance that can contribute to an overall better safety management over time, continuous making improvements towards quality and safety.

- Constraints

Legal requirements - Local and International – Constraints

The legal requirements in the O&G industry projects applies to the specific activities involved. The legal requirements for projects on the NCS are known for being very strict compared to international standards. Therefore, complications can arise in projects where one part have difficulties adopting the requirements.

The review of projects revealed significant deviations in legal requirements of Norwegian standards. International contractors struggled to deliver according to Norwegian contract stipulations and requirements for quality and HSE. The observed deviation from Norwegian standards is a constraint on the efficiency of the project. Problems with adopting quality requirements resulted in rework, delay and extra costs.

In modern days, many operators on the NCS follow Statoil's TR-stipulations (Technical Requirements) to ensure safe design/operation for development. The stipulations are actually stricter than those acquired by the government. Companies have now realized that in many situations, these stipulations causes unnecessary cost exposure and it has become more normal for companies to move away from these requirements. Besides, contractors have traditionally negotiated for installation or design according to DNV requirements, and not Statoil's TR. Effective cost cutting is a general trend that can be observed all over the oil & gas industry.

A long-term alliance with an international contractor where knowledge is carried on from project to project is over time expected to better the understanding of Norwegian requirements for quality and HSE. Formation of alliance can improve the parts understanding of each other's culture, improve communication, friendship, and provide transparency. These factors can increase the efficiency of seminars/courses, which contribute to better the partners' understanding of Norwegian requirements.

Different objectives of operator/contractor - Constraints

The congruence describes how well the parts share goals and objective to the same extent. In projects with low congruence and fixed price (different objectives), the supplier will primarily reduce own costs and produce cheapest possible as opposed to operator who wants high quality, low cost.

The reviewed projects mostly revealed low level of congruence, where the parts had different objectives and contractors primarily reduced own costs. The Yme project showed how the contract format compromised the operator's ability to perform quality control because it would mean involvement and additional manhours in document review cycles, site visits, audits etc., which SBM had no economic incentive to allow for. For the Goliat project, the design- and technical complexity on the FPSO compromised the contractor's ability to perform according to demands for quality stipulations. The contractor wanted to deliver according to quality demands, but not in the extent that all defects would be fixed at their own expense. For project E6 Langslett-Sørkjosen, the contractor could not meet quality demands with their insufficient equipment. The contractor hired a Swedish entrepreneur to increase quality, but showed not enough congruence for delivering according to quality demands because they did not upgrade own equipment.

Strategic alliances can achieve higher level congruence level by aligning the partners strategy, objectives, sharing risks and rewards. This will make the partner focus on maximizing the projects life cycle value which requires accounting for income, flexibility and modern technology. Reaching high level of congruence will make the parts focusing more on delivering value over the projects life time, rather than only minimizing their own individual costs.

❖ Opportunities

Waste reduction to go 'lean' – Opportunity / Value

An echo of the market conditions can be viewed in the enormous downsizing of staff in Norwegian O&G and OFS companies. According to *Reinertsen AS* [46], a modern focus among the biggest players on the NCS is finding out how operator and contractor can work together and maximize efficiency. This involve more dependency in interactions between the parts. Major oil companies are now focusing in an increasingly extent on using weight as a measurement parameter, and utilizing all the work that can be completed onshore (avoid work hours offshore). It is crucial to find the best practice for standardized working methods. This involves checking up on quality deviations, improvement proposals etc. It is important to see the big picture in order to find out which area is most suited for improvements.

The current market condition has encouraged waste reduction within implementation of projects. A common objective among the major players on the NCS is to reduce costs in all joints of offshore implementation projects with 50% [46].

- Target/goal for EPCI contracts (50% reduction in all parts)
    - Engineering (-50%)
    - Procurement (-50%)
    - Construction (-50%)
    - Installation (-50%)

Major players on the NCS are focusing on the following actions to achieve 'lean' implementation:

Engineering: Potential improvements in FEED phase involves earlier decisions, no alternatives, better priorities – effective engineering (streamlined systems). Changes in detailed engineering involve plan for infrastructure/network plan, live updates (real time communication), increased flow – frequently updating the progress in order to monitor which joints needs more resources so that delay are avoided and dependable activities are not being disturbed (-50%).

Procurement: Challenge contractor and identify potential. Challenge already established requirements (the contractor's standards, SEMI) (-50%).

Construction: Earlier involvement and decision of material and concepts, detailed planning (system oriented plan), cost effective subcontractors (-50%).

Installation: Earlier involvement in decision of equipment and concepts and management on the field. The contractor's systems (job setting, material management and MC). More effective work day (reduce indirect hours, logistics) (-50%).

Achieving a 'lean' production can be difficult because it require close dependency between the operator and contractor organizations. The parts might not have sufficient incentive to help each other optimizing their solutions. A strategic alliance will align the objectives of the partners, facilitating for increased efficiency through close collaboration and transparency between the partners involved. The findings therefore suggest waste reduction to go 'lean' might be more suited in a collaborative environment.

Multiple contractors 'Alliance contract' – Opportunity

Description and characteristics of strategic alliances are already mentioned, therefore the following part will review the results from the study of projects and how an alliance could have been beneficial.

The review showed how Norwegian operators experienced significant challenges with cultural differences and deviation from Norwegian requirements in the execution phase.

As a lesson, in projects where multiple cultures are involved, an opportunity for Norwegian players is integrating with foreign contractors. An alliance where the parts together conducted the planning phase and design could improve the transition over to execution phase. It could entail a competitive advantage to cooperate with contractors who own or have close relationship with shipyards (Hyundai heavy industries, Samsung heavy Industries etc). Risk associated with such large-scale projects could potentially be reduced. Benefits from such integration could be increased understanding of NORSOK and Norwegian requirements for HSE, increase congruence between the parts and a better ability to implement incentives in the contract. It will also be easier to pass along incentive elements to local subcontractors on the shipyards.

Frame agreements – Opportunity / Risk

Frame agreements are a contracting method where some contractors and operator collaborate in several projects. This method is contrasting to the conventional project-by-project approach where operators use different contractors for each project. Frame agreements are based on establishing common standards and protocols, which continues from project to project. In this way, the operator have a set of approved contractors. Frame agreements is an opportunity to increase value in traditional project implementation, and has proved to reduce costs and increase collaboration. However, frame agreements 'lock' the involved partners together for the frame agreements contractual duration, and the agreement can impose displeasure and risk if outside contractors reduce prices [41].

Strategic alliances contain many of the same elements as a frame agreement. The collaboration over a specified time period will facilitate for experience transfer and reuse of technology, providing continuous improvement. However, a strategic alliance create better collaboration because objectives are aligned, and risks and rewards are shared. This can provide a significant advantage compared to frame agreements.

- <u>Risk/Value</u>

Function but not the Product – Value

Traditionally, the practice within tender process is that the oil company specifies service-execution requirements and material-supply metrics in detail. From the contractor's perspective, it is preferable to work with a function that can be solved in a desired way, rather than delivering a product with certain specifications. Letting the contractor manage execution details and own solutions will introduce more flexibility and will be basis for utilizing the contractor's expertise, which can contribute to maximize productivity and improve quality. The service provider will also be able to pool assets with multiple other projects in parallel. Operating with a function is easier to achieve through integration from an early stage of the project where the operator and contractor can come up with an optimized solutions for both parts.

In a strategic alliance, partners can collaborate from an early stage of the project, especially in the design phase, and together find the optimized solution to a product or service. The more partners involved, the greater is the resource pool available for use. The collaboration enables the contractor to increasingly influence concepts, costs and contribute to maximizing value. It is important to identify all value opportunities and consistently choose solutions and concepts on basis of value. The integrated relationship can therefore utilize more of the contractor's expertise, which can therefore be basis for creating more value than with the traditional relationship.

Opportunities to improve (value) / Lost opportunities (risk)

Recognizing and capitalizing on arising opportunities in projects can create major economic value for the parts involved. It is basis for maximizing efficiency and achieving a successful project. Conversely, avoiding lost opportunities leads to efficiency loss, which can introduce a risk for the project. One can recognize opportunities from lesson learned or experience gain such as staff feedback regarding optimization of processes or HSE. It is important to account for boundaries or obstacles that can prevent opportunities. For example, projects are increasing in size, complexity and often involves many cultures. Without good communication and understanding, lost opportunities can arise. It is important to note that some opportunities can be difficult to recognize in today's market situation due to the substantial high focus on cost and budget.

Strategic alliances, due to its many advantages, are more facilitated for recognizing opportunities to improve value. Such advantages come from close collaboration, shared objectives and a common goal to maximize life cycle value of the project.

Bonus for better performance over Base line – Value

The traditional contract regime in the O&G industry is structured in ways that do not compensate suppliers based on performance. It is crucial that contracts are structured in a ways that encourage suppliers to improve efficiency, cut costs and pass these incentives along to sub-contractors. Implementing incentives in contracts can help motivating suppliers to cut cost and improve performance.

However, the main challenge have traditionally been applying measureable parameters. It can seem complex to implement because the number of variables that needs to be defined for each contract model increases for incentives/PBC. Because of this, it is important to find the balance between complexity and implement ability. Wrapping the head around such agreements can seem complex, and it can be argued whether such contracts might be more suited for growth in a collaborative environment [36].

A strategic alliance enables closer collaboration and can be a more suited environment for development of such contracts. Since the partners involved bring experience from one project to another it can facilitate developing measurement parameters (such as key performance indicators) along the project execution.

6.5.4 Benefits

The following part presents a number of identified key benefits and obstacles from past collaborative relationships in the O&G industry. The experiences showed important factors contributing to more efficient, effective delivery of projects, as well as strengthened capabilities and competitive positioning [41]. Table 6.5 show the identified key benefits of strategic alliances.

Table 6.5 Identified key benefits of strategic alliance [41].

Efficiency	▪ Less sourcing since there was no need for tendering work ▪ Contracts more standardized ▪ Competitive prices in return for stable work
Effectiveness	▪ Earlier contractor involvement, especially design phase (influence concepts, costs, solutions) ▪ Transfer of experience/knowledge from project to project ▪ Stable work environment provides growth for continuous improvement
Strengthened capabilities	▪ Entry to flexible, global, scalable pool of resources ▪ Shared standards, practical specifications and operations and tools to facilitate the use of repeatable capabilities from one project to another ▪ Training/schooling and exercises that improve skills and other work force development ▪ Innovative technology development as a result from the alliance relationship
Enhanced competitive positioning	▪ The capability of completing projects more effectively and efficiently ▪ Less risk and resource commitment when delivering of projects ▪ More flexibility to counter varying market conditions ▪ More global reach due to the expanded alliance ▪ Improved reputation as a result of new field developments and experiences from the expanded alliance

6.5.5 Challenges & success factors

There are also multiple challenges when creating a strong alliance. They are in practice hard to implement, especially for large companies with long-term established cultures. The following challenges were identified from alliance relationships in the O&G industry.

Common challenges:

- *Culture differences*. The parts have difficulties adapting to the other parts adversarial mentalities
- *Wrong management focus*. Challenges and issues facing the organization on other fronts can lead attention away from the alliance
- *Integration problems.* The organizations fail to build relationships and adapting traditional working methods to new methods more suited in alliances
- *Worker resistance.* Workers have a tendency to approach alliances with pessimisms, while leaders often support it
- *Meeting expectations.* The alliance struggle to achieve the benefits preliminary envisioned by the parts.
- *Poor contract design.* Inadequate contract terms and bureaucratic resistance that work against collaborative behaviors
- *Momentum.* Initial positivism may be negatively affected by implementation challenges

Success factors:

New strategic alliances must create proper foundation in order to avoid typical pit falls. Figure 6.3 presents practices that are, based on experiences in the O&G industry, factors required for forming a successful strategic alliance.

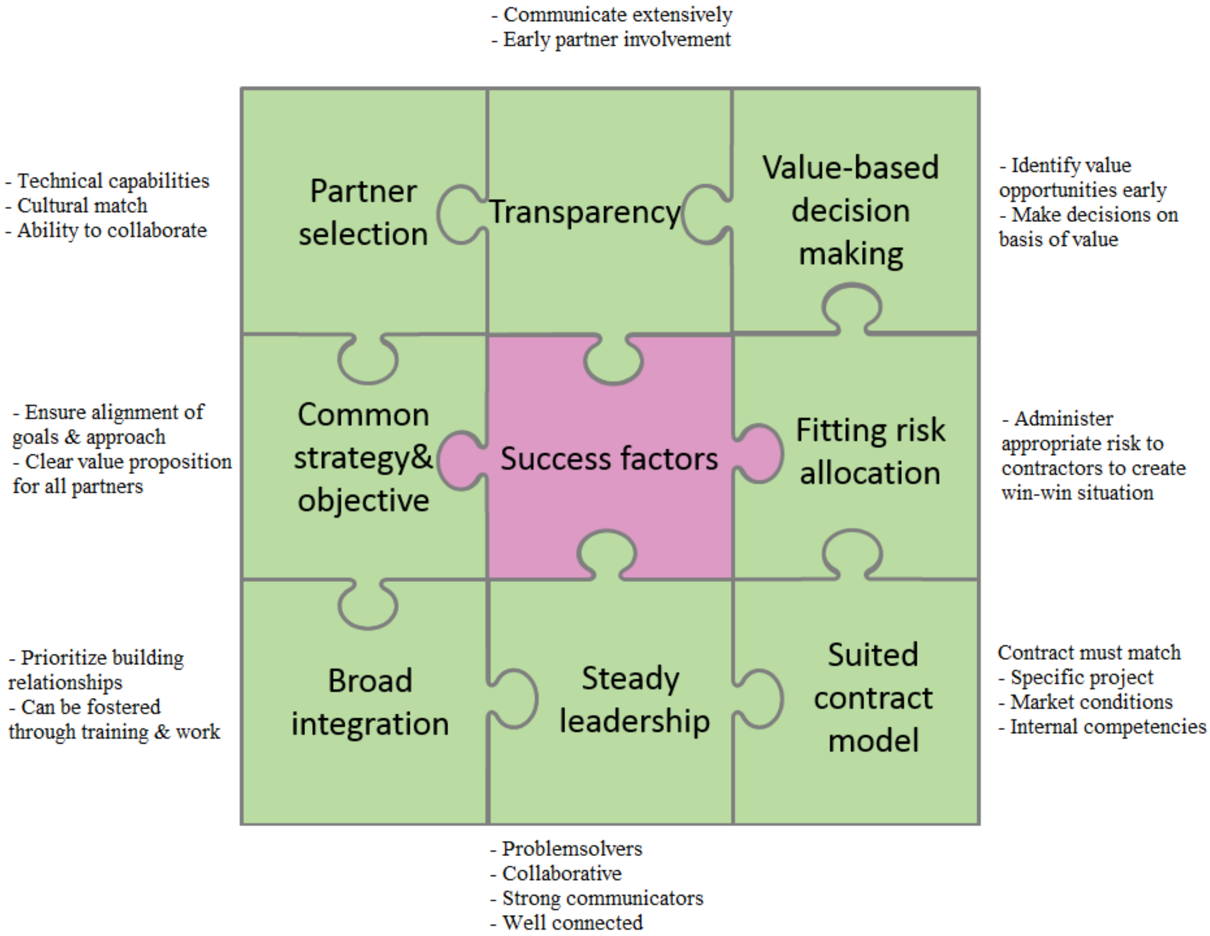

Figure 6.3 Success factors for Strategic alliances, modified and based on [41].

6.6 Addressing common challenges

A next step for improving strategic alliances are addressing the identified challenges. From the experiences mentioned earlier, common challenges involve *culture differences, wrong management focus, integration problems, worker resistance, meeting expectations, poor contract design* and *momentum.*

Historically, industrial clusters have been a mix of companies, organizations and institutions in a specific geographic region. For the companies involved, clusters help improving productivity and competiveness. It is also beneficial for the Nation and industry as a whole, since the clusters help increase economic performance and improve progress [45].

As a further approach to alleviate and address the challenges observed, an opportunity could be to create an industry cluster devoted for strategic alliances. The objective would be to share experiences among alliance organizations, creating more value and a win-win situation for all parts involved. Because the reported challenges were mostly based on integration elements, the alliance organizations involved in such cluster do not have to worry about holding back information, (for example hide innovative technology elements). In addition, the problems are not unique to the O&G industry, which suggest that an industry cluster for strategic alliances can possibly also conform across several industry sectors.

However, industry clusters come with boundaries, like all other organizations. Traditionally, the most significant boundary for clusters has been geography. Although regional clusters comes with benefits, it is also a major limitation for further development of the cluster. On a global scale, a boundary less organization cluster (a cloud/real-time communication) can provide more activity, improved flexibility among clusters and a greater ability for the participants to adapt the change in the environment outside their geographical region.

Because O&G is a global industry sector, a cluster for strategic alliances should involve a communication model without a geographic boundary, which through better experience flow can create growth for opportunities to improve and together create more successful alliance relationships.

7 Discussion

7.1 Lessons learned

The conducted study of four major development projects across two industry sectors gave the following extracted lessons:

- *Allocate resources efficiently in early project phase*
- *Ensuring good interaction with contractor and other sub-contractors*
- *Ensuring compliance of Norwegian requirement for standards & HSE*
- *Select a contract strategy that ensures participation, follow-up, influence & transparency*
- *Adapt the contract strategy to the level of risk and gains with right incentives*

Many of the same lessons can be observed from past project reviews by the NPD. It may suggest that projects have been constrained by the traditional contract regime. Continuously seeking performance improvement help create value and can be crucial for survival in today's conditions. There are limited options for Norwegian O&G and OFS companies to adapt the tight market conditions. In an attempt to counter the adversarial market conditions and low oil price, this thesis identifies three options for Norwegian O&G and OFS companies that can possibly strengthen their competitive positioning;

- *Strategic alliance*
- *Risk-gain sharing agreements & PBC*
- *Waste reduction to go 'lean'*

This thesis argues that a strategic alliance can improve the competitiveness for players on the NCS by bringing the following value opportunities:

- *Shared & strengthened capabilities*
- *The integrated capacity supports for effectivity & efficiency growth*
- *Stimulate for innovative technology development*

7.2 Further Development of Strategic Alliances

In the development of this thesis, the writer participated in a hub meeting with CIAM, where participants from various industry companies exchanged expert opinions and experience sharing. Applying the same concept devoted for strategic alliances can entail advancements and a better ability to address the challenges traditionally observed.

By developing boundary less industry clusters devoted for strategic alliances, independent alliance organizations can through real-time communication on a global level provide experience sharing with other alliances, improving flexibility among organizations and provide better conditions for developing a successful strategic alliance.

7.3 Future study

A suggestion for future study is connecting with companies within a strategic alliance in order to access contract details and develop a more specified framework. It would also be fascinating to further investigate how the interests and benefits for creating alliances changes when the oil price fluctuates.

7.4 Challenges

A challenge in writing this thesis was collecting data. Two out of four studied projects did not have official publications of projects reports, making data collection time consuming. Moreover, companies involved in these projects did not wish to give a statement or perform interviews. The majority of data collection is therefore based on publicly available sources.

8 Conclusion

The thesis studied four major development projects across two different industry sectors, pointed out common pitfalls and extracted important lessons.

- As an attempt to counter the challenging market conditions and low oil price, the thesis identifies three options that can help strengthen competitive positioning for Norwegian O&G and OFS companies:
    - Strategic alliance,
    - Risk-gain sharing agreements & PBC
    - Pursing the concept of waste reduction to go 'lean'

- The study findings suggest strategic alliance is an effective option for Norwegian players to adapt the market changes. An alliance between operator and contractor organization can provide value opportunities due to strengthened & shared capabilities, integrated capacity that supports growth for effectivity & efficiency, and stimulation of innovative technology development.

- The study also revealed challenges related to strategic alliances. It is suggested that these challenges can be alleviated by introducing industrial clusters devoted for strategic alliances. Traditionally, clusters have mainly been limited by the geographic boundary. Removing this boundary and introducing real-time communication between strategic alliances on a global level can provide growth for better experience flow, more opportunities and more successful alliance relationships.

- A suggestion for further study is connecting with companies within a strategic alliance to access contract details and develop a further specified framework. It is also suggested to further analyze how the interests for creating an alliance changes as the market and oil price fluctuates.

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