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How clients influence building projects

A comparison of the construction industry and the petroleum industry in Norway

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Industrial Economics

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PREFACE

This thesis is a written paper that symbolizes the finalization of our Master's degree in Industrial Economics at the University of Stavanger.

The initial goal of this research was to perform an objective comparison of the project management practices within the construction industry and petroleum industry in Norway. After gaining deeper understandings of the industries, we understood how the petroleum industry in many ways, is ahead of the construction industry. As a result, we directed our focus on the challenges in the construction industry by learning from the petroleum industry. We hope that this research is a contribution to the literature about the Norwegian construction industry, and that it highlights essential challenges and potential areas for improvement. We hope to inspire for further studies, so that corrective actions can be taken in the future.

We would like to express our sincere gratitude to all interviewees that have taken their time to share their experiences and knowledge with us. The conversations have provided us with a greater understanding of the two industries, and have been essential for our work. Special appreciation is also given to Arne Vingen and Andreas Hoftun for their constructive engagement and recommendations, and to Lasse Myhre for his contributions. Finally, we would also like to express our thankfulness to our faculty supervisor, Frank Asche, for his time and academic competence.

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EXECUTIVE SUMMARY

Several studies indicate the need for competence and quality improvement in the Norwegian construction industry. Findings show that diversity in client groups can lead to different levels of competence. This poses many challenges to the industry and those involved, all of which will be highlighted in this thesis.

The objective of this thesis is to provide an understanding of how clients' levels of competence and focus can influence the final results of building projects. This thesis provides a comparison between the Norwegian construction industry and the Norwegian petroleum industry in order to exemplify the findings and provide a solid basis for recommendations for the construction industry.

Ten in-depth interviews with various people from contracting companies and consulting firms within both industries have been performed. Information pertaining the clients, along with general practices for planning and control in the industries have been addressed and categorized. It is further analyzed how differences in client competence and focus affect practices for planning and control, and in turn, how this impacts the projects.

The research has addressed several differences in practices for planning and control in projects of the two industries. Projects in the construction industry seem to be executed with less planning and control, which in many cases can be led back to poor competence among clients. The analysis shows how insufficient planning and control give rise to late changes, resulting in re-building expenses and in turn affects the project results. Poor competence among clients will also have a direct impact on the projects through late client-initiated changes. The research underlines that the construction industry has great potential for quality enhancement, and a lift in the competence level among clients is likely to give both quality improvements and higher project profitability. Compulsory arrangements are considered to be the most effective approach to meet this challenge, meaning that the Norwegian Government needs to take the final responsibility for implementing sufficient measures in the future.

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1 Introduction

1.1 Background

Byggekostnadsprogrammet is a Norwegian research and development project that began in 2005 with the support of the Norwegian government. The objective of the project was to enhance the quality of buildings and construction in Norway whilst also increasing the profitability of the construction industry in the country (Byggekostnadsprogrammet, 2008). This research program generated an array of extensive reports, many of which, found that lack in client competence, particularly in the areas of commercial understanding and project management skills were reoccurring issues for contractors, having detrimental effects on the success of the project. Further to this, several reports indicated that various projects had been delivered to poor standards and with substantial errors. Meland et al. (2009) found that overlooking the importance of project management in many building and construction projects is unfortunately an everyday reality. As a result, poor planning and development in the areas of engineering and design are an ongoing problem in the industry.

The research program indicated that the Norwegian construction industry was in dire need of substantial improvements. The government has since undertaken initiatives to enhance a more profitable development of the industry. The ambition of the program is to give the Norwegian construction industry a lift in the level of competence, and to enhance quality.

Prior to the R&D project of 2005, literature studies were lacking in the area of the construction industry in Norway. This led some researchers to seek knowledge from abroad, with the objective of finding applicable solutions from the same industry elsewhere. Various studies performed in Denmark, Sweden and England were observed, and some of the reports made in *Byggekostnadsprogrammet* revealed that several other countries had similar challenges to those faced by the Norwegian construction industry. A research undertaken by Latham (1994) in the UK, also addressed issues regarding clients in the construction industry. His research highlighted that clients who do not understand their needs create a frequent need for changes in the engineering and design phase of building and construction projects. This

research also describes how the same issue would lead to increased costs and thus weaken the project in general. In Norway, a diversity of client groups in the construction industry gives rise to various levels of competence among clients. This underlines the importance for contractors to manage and control the clients, as their wants and needs may change with each project.

1.2 Objective

The main objective of the thesis is to derive an understanding of how clients influence building projects in relation to planning and control. Further to this, understand how poor planning and control can lead to late changes, which may in turn affect the project result. By identifying differences in clients' competence and their focus in relation to cost, time and quality, it is possible to describe how it influences the degree of planning and control performed in building projects. A comparison with the Norwegian petroleum industry will allow this thesis to identify challenges in the construction industry, and further point out opportunities of improvement.

As previously mentioned, various researchers have looked to other countries to find solutions to improve the issues present within the construction industry. In order to provide recommendations and improvements for the construction industry, this thesis will analyze the inner workings of the Norwegian petroleum industry- an industry which is extremely established and successful. The industry is renowned for its strong focus on quality, as a result of complex and harsh conditions offshore, with high associated risk. A prominent quality culture has over time developed, in which detailed planning, engineering and tight control seem to dominate every project and operation in the industry. This has been a key factor for the petroleum industry to enhance safety, reliability, and quality in projects. A comparison of the construction industry with the petroleum industry in Norway will enable this thesis to illustrate the underlying reasons for why the focus on planning and controls vary between the industries. The comparison aims to develop a much deeper understanding of the construction industry.

1.3 Limitations

The Norwegian construction industry is divided into two segments: *building* and *construction*, which is further described in chapter 3.2. The construction industry is composed by various client groups, in which the building segment holds most of the diversity of client. The objective of this thesis is to study the influence clients have on building projects. Therefore, the building segment is more applicable for this research objective. As a result, only the building segment of the construction industry will be studied in this thesis. The term *construction industry* will further be used, despite the fact that this thesis is limited to the building segment of the construction industry only.

The Norwegian petroleum industry is divided into four main segments, in which the topside segment involves the participations from a majority of the suppliers present in the industry today (further described in chapter 4.1) For this reason, this research has been limited to only include the topside sub-sector of the industry, as it is inappropriate to study all segments with the given time-constraint at hand. The term *petroleum industry* will still be used in this thesis, although only the topside sub-sector is being considered.

2 Project management fundamentals

2.1 Project constraints

According to Wysocki (2009), there exist five operating constraints for all type of projects: (1) Scope; (2) Quality; (3) Cost; (4) Time; and (5) Resources. For the purpose of simplicity, only cost, time and quality will further be considered in this thesis. The understanding of the relationship between these three project constraints forms a basis to discuss how clients influence projects.

Quality is an important term in this thesis, as it will often be mentioned in relation to client's competence and focus, and when discussing planning and control. Quality can be divided into *product quality* and *process quality,* in which product quality represents the quality of the project deliverables, and the process quality represents the quality of the management process itself. However, a change in quality leads to a change in scope, but not necessarily the other way around. The triangular relationship is presented in Figure 2-1. The constraints are all interrelated, and a change in one constraint will normally affect one or more of the other constraints (Wysocki, 2009).

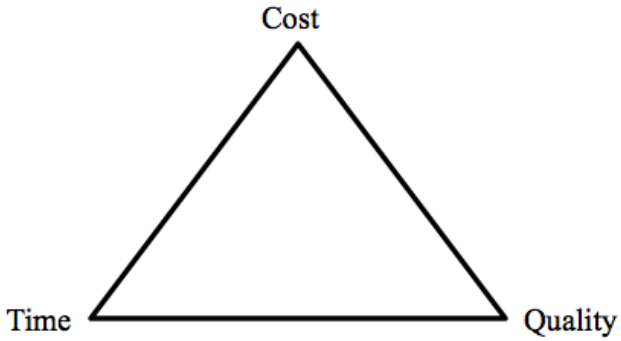

Figure 2-1: Triangular relationship of time, cost, quality

The Project Management Institute (2013) states that project success can be measured in terms of completing the project within the operating constraints approved by the authorized stakeholders. It is the project manager's task to balance the project according to the given

constraints, and at the same time, assure that the level of risk is not exceeding the chosen risk profile. The project manager is responsible for completing the project within the given constraints, and also responsible for setting realistic boundaries as to what can be delivered for a given cost and within a given time. Before the project starts, the client has to provide priorities for the constraints, in order for the project manager to make trade-offs when problems or changes occur (Gardiner, 2005). The project is in balance with the client's approval of the planned constrains at the start of the project, and before any work has started. After the project has been initiated, elements in the project may change, which puts the project out of balance. The scope triangle can be used as a problem-solving tool to see where adjustments can be made, or as an impact analysis tool for various changes (Wysocki, 2009).

2.2 Project stakeholders

It is important to understand that the stakeholders' role in a project, as it will be discussed in relation to projects in both the construction industry and petroleum industry.

According to PMI (2013), Ottoson (2012), and Gardiner (2005), the following roles are usually included in a project:

- **Client** (or project sponsor/owner) is the individual or organization initiating the project, providing the financial resources and has the right to the project output. The client sets the project framework (i.e. functional requirements), and is in most cases the contracting authority towards other project participants. Furthermore, the client is in a position to make the formal decisions concerning the project output, and will lead the project through its initiating phase (including development of the project scope). Additionally, the client is throughout the project involved in authorizing scope changes, phase-end reviews and go/no go decisions.
- **Project board** (or steering committee) is the group of people given the responsibility of directing and managing the project on the client's behalf. The project board often exists of people from the client organization, but can also be an external organization representing the client.
- **End users** are the persons or organizations that are going to use the final product. The client and end user are in some cases synonymous, but often the client can be seen as the entity acquiring the product, while the user is the utilizer of the product.

- **Suppliers/contractors/consultants** are external companies/organizations providing services or components to the project through a contractual agreement with the client.
- **Project team** consists of the internal individuals working for the contractor with the main responsibility of managing and executing the project.

2.3 Phases of the project life cycle

A project normally moves through a set of phases, which is often called the life cycle of a project. Each phase ends with the completion of one or more deliverables, and it will be transferred to the next. Figure 2-2, shows traditional phases of a typical project. The theoretical project phases will be used as a basis to describe projects in both the industries.
For some projects, additional phases are added to the life cycle, such as operation, maintenance, decommissioning, disposal and logistics**.** Such phases are often considered as new, individual projects.

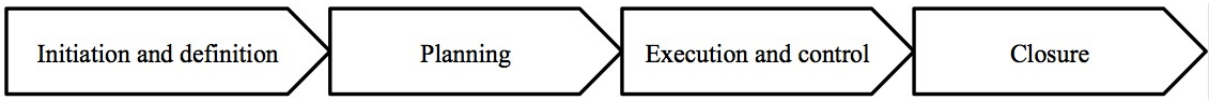

Figure 2-2: Traditional phases of a generic project life cycle structure (Gardiner, 2005)

In addition to the traditional project phases, PMI (2013) also defines **t**he five Process Groups as following: (1) Initiating; (2) Planning; (3) Executing; (4) Monitoring and Control; (5) Closing. Any of the generic project phases can compromise processes from a particular Process Group, but normally most or all processes will occur in each phase. Dividing a project into phases enhances the project control, since progress of each deliverable can be monitored phase by phase. Milestones and evaluation points can be set between the phases, to detect deviations from the plan and make correction (Gardiner, 2005). Figure 2-3 shows how cost and allocation of resources naturally develop in a typical project.

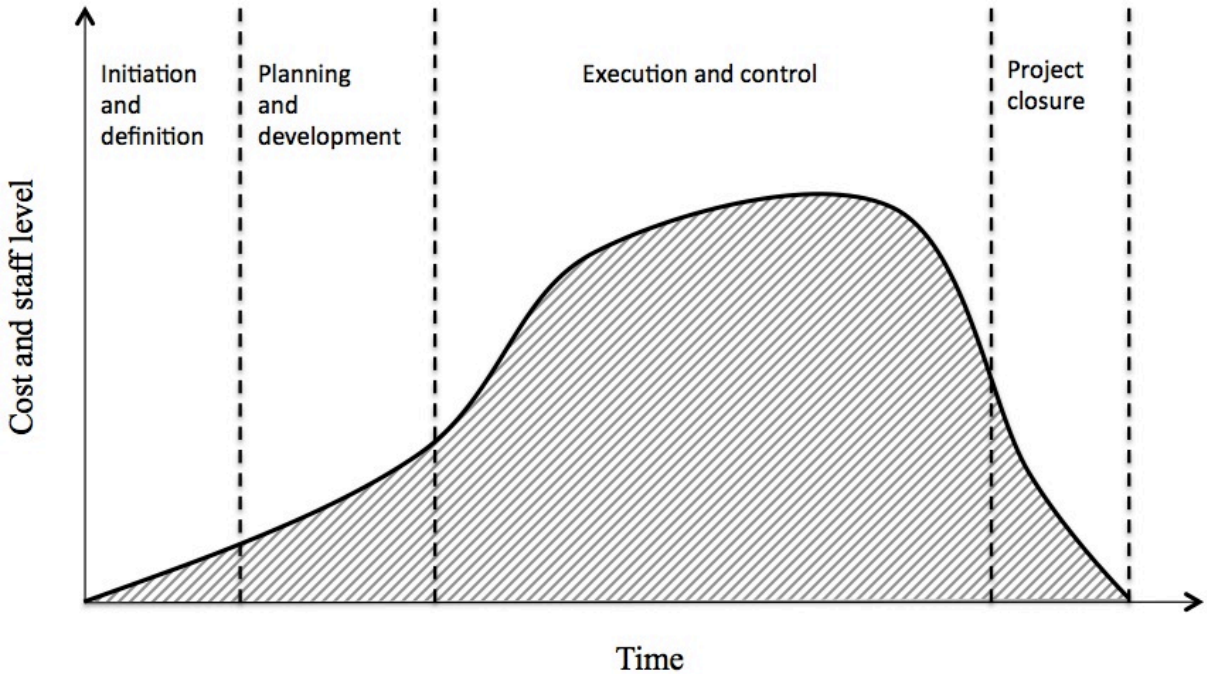

Figure 2-3: Typical development of cost and staff level in a project (PMI, 2013)

The following project phases are presented in accordance to Gardiner (2005) and Wysocki (2009):

- **Initiation and definition (starting the project)**

In this first phase, sets of activities are carried out in order to define the project scope. A feasibility study is also conducted for decision-making to go ahead with the project investment or not. Already in this phase, major decisions need to be made concerning the design of the project deliverable(s) and forming the project strategy on how to obtain the output.

- **Planning and development (organizing and preparing)**

This phase will form the basis for future project control, and the following activities are to be performed in this phase: (1) Creating all relevant project plans, such as management plans concerning scope, quality, risk, HR, resource- and budgetary plans, work plan and timeline; (2) Mobilizing and organizing all required project resources; (3) Establishing the infrastructure to support resources as well as securing communication between all project stakeholders.

- **Execution and control (carrying out the work)**

In this phase, the project sponsor desire to see results, meaning that all deliverables are delivered on time and meeting expectations. The cost rate will normally be at its steepest point in this phase. As the project evolves, new information gives the client a better understanding of the project, which may lead to change-order-requests. Such requests often occur in this phase, as the client sees that the project outcomes will look or operate differently than initially intended or as originally requested.

- **Closure (closing the project)**

The project closure takes place when all project activities are carried out. The process involves closing off the project budged, and performing all outstanding payments, completion of documentation and administration requirements. After a final inspection with the client, the project deliverable is handed over to the client, involving a warranty period by the responsible contractor. In the closing phase, internal project evaluation is common practice as a "lesson-learned" transfer for future projects.

2.4 The importance of planning

A major part of the research objective at hand is to determine how clients influence planning, engineering and design. Hence, it becomes essential to understand the importance that planning activities have for a project and how it can enhance project success.

Wysocki (2009) emphasizes that planning: (1) reduces uncertainty, (2) increases understandings and (3) improves efficiency. Figure 2-4 illustrates the risk and uncertainty development throughout a project.

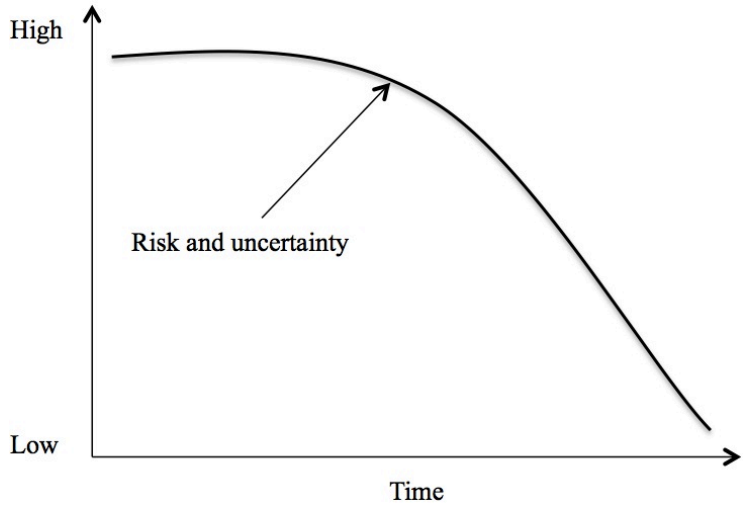

Figure 2-4: Development of risk and uncertainty (PMI, 2013)

"If you are to be an effective project manager, a project plan is indispensable. Not only is it a road map to how the work is scheduled, but it is also a tool to aid in your decision-making. The plan suggests alternative approaches, schedules, and resource requirements from which you can select the best alternative."

(Wysocki, 2009, p. 112)

Hence, a plan is a major success criterion of any project. Wysocki (2009) suggests that an ideal approach for any project is to invest a considerable amount of resources early in the project, as shown in Figure 2-5: Pain curve of planning (Wysocki, 2009). Although it is painful in the beginning, it will reduce and become more beneficial later. Furthermore, Wysocki (2009) argues that good planning can save the project 18-36% time compared to poor planning. However, real-life situations and conditions can make it challenging for various projects to achieve an ideal pain curve as shown.

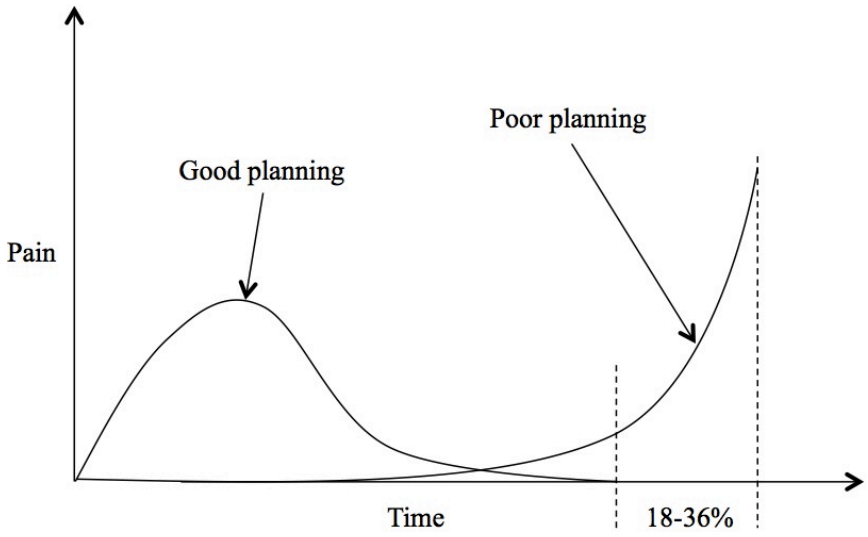

Figure 2-5: Pain curve of planning (Wysocki, 2009)

2.4.1 Work Breakdown Structure (WBS) and work package

Work break down structure is an important tool for planning and it is a common method, utilized in both industries. Gardiner (2005) describes that WBS is an important tool for communication in the planning and development phase. It visualizes work that has to be performed in order for the project to be completed, and thus create a common understanding for all participants in the project. Furthermore, it illustrates the resources required for each activity, and the dependencies between them. The WBS can break the project activities down to several levels. The level included is dependent on the project complexity at hand, and the end of each branch can contain work packages for management and control purposes. Work packages usually constitute the lowest level of the WBS. Wysocki (2009) illustrates that work packages can be integrated into status reporting activities, with start and end dates, and can also be implemented on several stages of the project, such as for engineering and design, for production and installation. A work package usually consists of several tasks. The work packages are assigned to a task manager (individual or group of individuals) with the responsibility to perform the work accordingly to the plan and time. Furthermore, a work package contains every description of the job to be done.

2.4.2 Joint Project Planning Session (JPPS)

Wysocki (2009) describes that JPPS is a group session that involves several people. The people involved in the project must sit down to generate a detailed project plan describing how the project is to be accomplished. Furthermore, team planning, in his opinion, is more efficient rather than having the project manager walking around collecting input for the plan. Another advantage with team planning is the strong commitment the plan will receive from the project participants. However, Wysocki (2009) refers to the JPPS as a session that is performed early in the project, in the planning and development phase. By recalling the five process groups (ref. chapter 2.3) planning exist within several phases. For the purpose of this thesis, JPPS can also be performed in the execution and control phase, as planning is necessary before production and building.

2.5 The importance of monitoring and control

Another part of this research is to determine how clients can influence projects by implementing systems and routines for control. It is essential to understand how monitoring and control measures help to lead the project towards a desirable outcome, and how they are beneficial for both clients and contractors.

The project constraints constitute a system in balance, which the project plan is based upon (ref. chapter 2.1). Monitoring and control routines are vital for the project in order to see whether the project is running according to the plan, or if there are any deviations from the initial plan. A project can run out of balance, and the project manager needs to take necessary actions to restore the project equilibrium. The purpose of control routines is to detect possible situations of a project going out of balance as early as possible and to be able to make changes quickly. The longer it takes to detect variations and decide upon necessary actions, the longer it takes to return to the project to equilibrium (Wysocki, 2009). Wysocki (2009) underlines the importance for a contractor to consider the requirement change request, which can come from the contractor's own team or client. Change requests are further described in chapter 2.6.

A reporting system is necessary to make sure that work is performed according to plan - on schedule and within budget. The objective of the reports is to detect deviations from the plan and allow early corrective actions. Too extensive reporting will reduce the available time to

perform actual work of the project, but requiring too little reporting will raise the risk of not being able to complete the project within the given constraints set by the client. Quality assurance is a necessary part of monitoring and control in order for the client to ensure that project work is performed in compliance with the plan and delivered with the quality standard given in the contract. There exist various methods that can be used in order to control quality, such as internal-monitoring by suppliers and contractors, third party controls, and inspections. Stricter quality regimes increase the chance of the client achieving expected quality as requested. The monitoring and controlling process needs to be organized and understood by the client, the project manager and all project team members. Furthermore, there should be a balance between the amount of time and resources spent in monitoring and control, and the associated value it gives (Wysocki, 2009).

2.6 Managing changes

Changes will be an important element in the analysis of the industries, and it is necessary to understand how changes arise and the effect of late changes. Clients in both industries can influence changes directly and indirectly, and poor understanding of changes can have a significant impact on a project's end result.

Wysocki (2009) underlines how projects are unique and dynamic. Projects require the implementation of change management in order to benefit from changes that will arise throughout the project (Gardiner, 2005). However, project changes do not necessarily lead to an unsuccessful project, but if not handled correctly they can cause the project to fail.
There exist many definitions and understandings of project changes, but the truth is that changes will affect the project constraints: cost, time and quality (Wysocki, 2009). Certain changes are inevitable and unexpected, while others are in some cases even desirable (Gardiner, 2005). Changes may arise within any project, and it is important to understand that not all changes lead to change-order requests, but that it is dependent on the contract and other project conditions as given.

2.6.1 Categories of changes

Changes can be grouped into categories based on how they are initiated. Changes are by Gardiner (2005) divided into three categories: (1) client-initiated changes; (2) changes initiated by the project team; and (3) changes as a result of external factors. Based on the understanding from Gardiner (2005) and Bolin (2013), changes can with respect to their nature and by the way they arise further be characterized as the following:

(1) Client-initiated changes

Design modifications

These changes are usually initiated by the client and the client's project board (the engineers), and address the design and such changes will require revision of drawings and predetermined specifications. These types of change are probably the most common change-order in a project.

Scope creep

The client may request a change of scope and thus extend the project's duration with additional scope of work and new specifications. This can be seen as a change in the original scope and is referred to as scope creep. Dependent on the type of request, the scope and the project may be extended or reduced.

Work sequencing

The client can request a change of the planned sequence of activities and which work sequence to be completed first.

Schedule acceleration or slowdown

The client can influence the project by requesting schedule acceleration or slowdown. Acceleration of schedule is the most common form.

(2) Changes initiated by the project team

Errors and omissions

These changes address elements in the project specification featuring errors or inadequate description, and are usually initiated by the project team as project activities and work are performed. Unforeseen physical conditions can in many cases lead to changes, in where actual conditions can partly or entirely distinct from the description in the scope/specification and thus form a false basis for decision-making and design.

(3) Changes as a result of external factors

Availability changes

These changes are caused by suppliers or sub-suppliers, and are initiated when they are unable to deliver services and goods as anticipated in terms of price, time and/or quality etc. Such changes can be caused by availability of materials, labor, equipment etc.

Mandated changes (third-party)

These changes are initiated by third-party regulatory organizations or regulations. They commonly concern safety and reliability of the design and the execution process.

2.6.2 Impact of changes

By viewing a project from a phase-to-phase perspective, it can illustrate some important characteristic with respect to the maturity of a project.

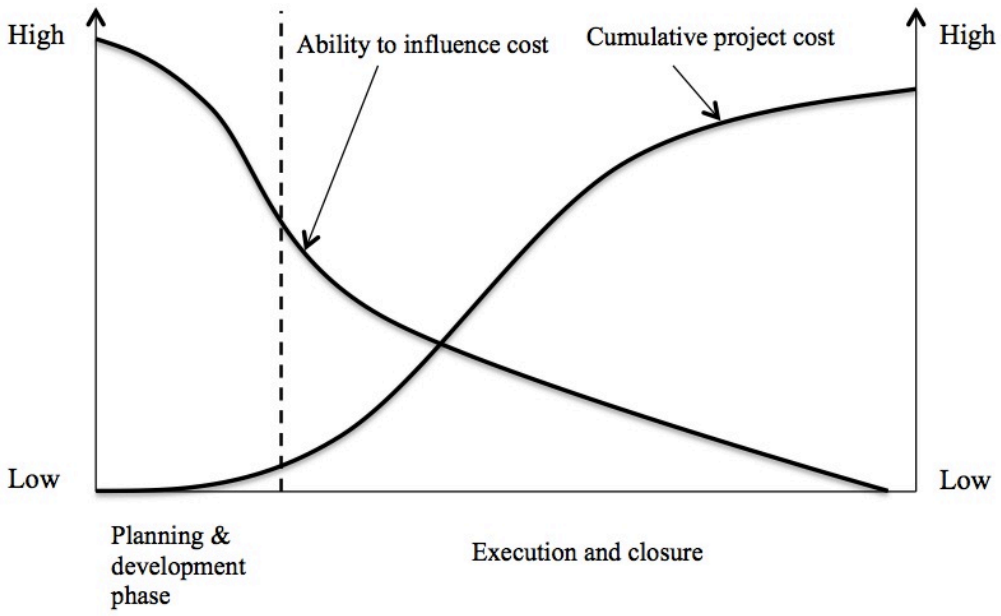

Figure 2-6: Ability to influence cost and the accumulated cost of change (PMI, 2013)

Figure 2-6 illustrates that the ability to influence cost is higher in the beginning of the project, and that the cumulative project cost increases rapidly in the execution phase. Figure 2-7 shows how the cost of change is lower in the beginning and will increase as the project develops.

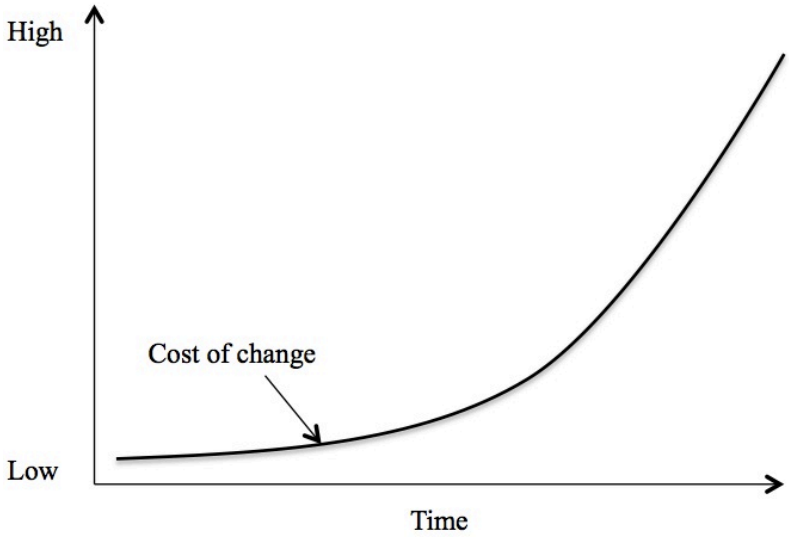

Figure 2-7: Cost of change (PMI, 2013)

The two figures provide the following understandings regarding changes:

- Project changes are preferred early in the project, since the cost of change is lower, and the ability to influence the project cost is higher.
- Changes that occur late are not desirable, since the cost of change is higher, and the ability to influence cost is lower.

2.6.3 Effective change management and the change process

Effective change management means that it is important and beneficial to identify and manage changes early in the project, to prevent extensive project delays and to ensure a more desirable result. However, that does not always seem to be the reality for many projects, since change management requires a lot of resources and dedication from the project manager and team. It is vital for the project manager to continuously and proactively control and influence the factors that create changes in order to economically benefit from them. It is important to determine when changes occur to formally alert the client in order to ensure future payments and effectively manage them as they occur. This practice will likely reduce project delays and enable the project manager to control future performance and quality (Gardiner, 2005). Hence, change management requires established routines and extra administration expenses, which can affect the profit of a project. However, it seems that change management often is neglected by contractors to the degree it is possible.

Changes to the original requirements in the contract can occur throughout the lifetime of a project for several reasons. If the change affects scope, schedule, budget and/or deliverables, all stakeholders that are affected by a change must review and agree on the request in relation to the requirements before they can be applied. When a change request is issued, the scope of work or schedule given in the contract might be affected. As part of the change process, an impact analysis of that reason should be performed for all changes of the original requirements before negotiations of accepting or rejecting the change can take place (Gardiner, 2005). Changes that are approved should be tracked in a change history and communicated to all project participants that are affected by it in a timely manner (Wysocki, 2009). Changes that occur because of poor specifications in the project basis will normally end up in a contractual negotiation in where the client, contractors and suppliers will have to make a decision on which party will have to cover the costs of the changes (Gardiner, 2005).

3 The Norwegian construction industry

The Norwegian construction industry, after the petroleum industry, has contributed to the greatest value-creation in Norway in the last couple of decades (Goldeng & Bygballe, 2013***).*** However, the industry is by some considered to be a conservative industry characterized by gradual development (Meland et al., 2009).

3.1 Value chain

Figure 3-1 illustrate the value-creation of the construction industry, which includes construction of new buildings, as well as rehabilitation and sale/disposal of buildings.

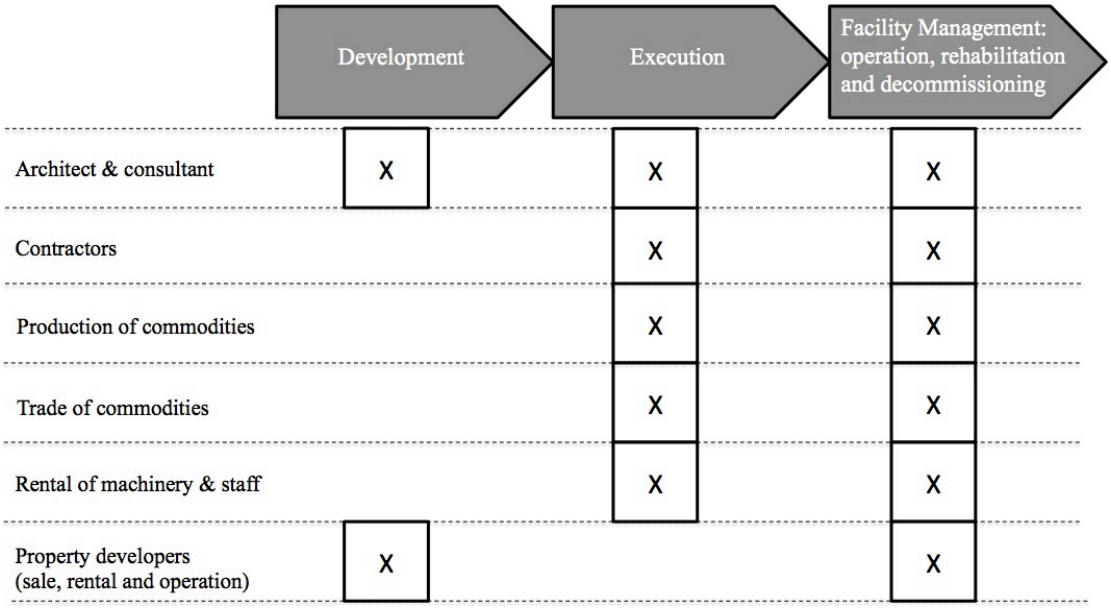

Figure 3-1: Value chain of the Norwegian construction industry (Goldeng & Bygballe, 2013)

3.2 Segments of the construction industry

According to Civil Engineering Website (2014) and Mishra (2012), projects in the construction industry are to be divided into four categories: *(1) residential building* (houses, hotels etc.); (2) institutional and commercial buildings (schools, medical facilities, shopping centers, offices etc.); (3) specialized Industrial construction (oil refineries, nuclear power plants and other high technological facilities); and (4) infrastructure and heavy construction (highways, tunnels, bridges etc.). In Norway, the construction industry is divided into two segments: building and construction, in where the building segment normally incorporates project category (1) and (2), and the construction segment incorporates project category (3) and (4). Both segments involve private and public firms and clients, and include new building projects, as well as rehabilitation and maintenance of existing facilities (Goldeng & Bygballe, 2013).

3.3 Project organization and stakeholders

Meland (2000) divides the project organization of a building project into sub-organizations that are directly involved in the project: (1) the client organization; (2) the user organization; (3) the designer organization; and (4) the contractor- and supplier organization. It becomes easier to understand building projects, by dividing it into organizations and roles.

(1) The client organization

The client organization normally includes the client, a project manager, a possible *site manager* (SM) and a *design group manager* (DGM). These roles can be seen as the project board, representing the client. Clients can have very different starting point. Some clients see the project as a one-time event, in which they also become the end users of the final deliverable, while some other clients are professional *property developers* (ref. Figure 3-1) with their own professional stab of people to execute the projects (Meland et al., 2009*)*. As a result, the client organization can consist of internal persons only, or can be an external organization managing the project on the client's behalf, as mentioned in chapter 2.2. The term project manager refers to both the client's project manager and contractor's project manager, and both managers have the responsibility to administrate and lead the project to

completion (Ottoson, 2012). The term project manager will further be used in relation to the contractor's project manager.

(2) The user organization

The user organization represents the end user of the final product, and could be identical to the client or the client's operational organization. However, in many cases the client is the developer (project sponsor), and the end users can be unknown through most parts of the building process. In most cases, a user organization exists with a user coordinator to interact with the client organization (Meland, 2000).

(3) The design organization

The design organization is responsible for the development of immaterial foundations, which is required in the production and building phase. Hence, making a complete design model as a basis for building activities, involves a coordinated set of multidisciplinary solutions from architects and consulting engineers. Therefore, the design organization is a multidiscipline organization. Furthermore, the design group's task is to secure the client's and end user's needs, and the most important output is the design model. The architects normally have the total responsibility for the design process of the project, including the coordination of participants and elements required in the design process, while the consulting engineers from all relevant disciplines perform the technical planning and engineering elements of the building (Meland, 2000).

(4) The contractor- and supplier organization

The contractors and suppliers are responsible for transforming the designed model into a complete building, by executing the project (building phase). *The suppliers* of the project deliver manufactured goods and parts to the construction site. *The contractor* performs the final production and building, and connects all parts to complete the functional product and/or deliverables. Furthermore, a contract defines the relationship between the suppliers and the contractors. As will be described in the upcoming chapter, several contract types exist in the building segment of the construction industry (Meland, 2000).

(5) Other stakeholders

Additional to the project organization and end users, construction projects also involve external stakeholders such as authorities and governmental regulators, other property owners, communities and public groups among others (Ottoson, 2012).

3.4 Phases and processes of a construction project

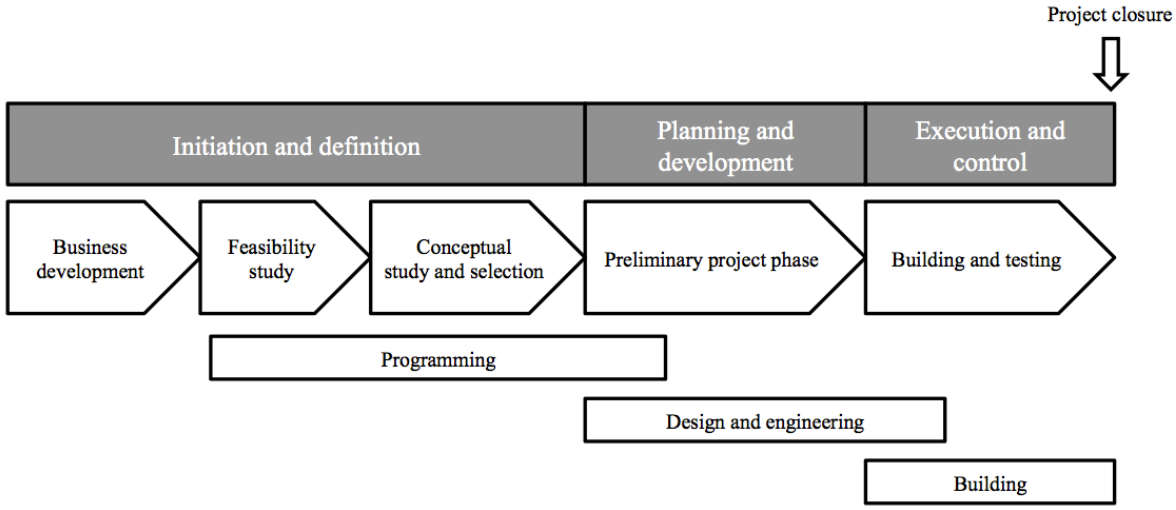

Figure 3-2: The generic phases of a construction/building project (Eikeland, 2001; Meland, 2012)

Figure 3-2 illustrates the phases of a construction/building project. Programming, design and production are the core processes, in which together constitute the building process. The programing process covers the activities of defining the requirements and design work, forming the basis for detailed planning and engineering in the planning and development phase. Furthermore, the design and engineering process lays the foundation for the building process by performing detailed descriptions of the project. The building process relates to the actual production (Meland, 2000). Distinguishing the programming process from design process is difficult, since the activities of these processes are often overlapping and correlated (Lædre, 2006). To reduce time, the design and building processes are often performed as partly parallel activities (Meland, 2000). The operation phase is normally assigned to the client, but involves a warranty period by the responsible contractor, in accordance with the contract. The building process is formally considered completed when the warranty period is over (Eikeland, 2001). What makes construction and building projects

unique, are the shifts of independent participant in the different phases. It is important to notice that the participants are from different companies/organizations and their stages of involvement are dependent on the contract form (Meland, 2000).

3.5 Contract types (*entrepriserformer*)

The contract type decides how the project is organized and how the responsibility is to be divided between the various parties. The client can, with the contract type, specify the framework for the contractors, which furthermore reflects the client´s, desired level of control. The longer the client is involved in the design process, the higher is the possibility of influencing design details. The contract form does not need to be static, i.e. a sub-contractor can enter into a direct contract with the client in the middle of a project, becoming both a contractor and sub-contractor. In Norway, there are four general types of contracts for construction and building projects that are commonly used: (1) Divided contracts (Delte enterpriser); (2) Design and construct contract (Totalentreprise); (3) General construction contract (Generalentreprise); (4) Principal contract (Hovedentreprise; Meland et al., 2009). The contract types (3) and (4) can be seen as hybrids between (1) and (2). Additionally, there are different consultant agreements, where the Construction Management Contract is the most commonly used. Appendix E introduces the various contract types mentioned in this chapter with more detailed explanations.

3.6 Regulatory framework and legislation

3.6.1 Central regulations

- *Plan- og bygningsloven (PBL):* The Norwegian planning and building act, providing legal framework for planning and building matters (Kommunal- og moderniseringsdepartementet, 2008).
- *Byggherreforskriften:* Regulation with the objective of protecting workers in relation to HSE elements in the planning, engineering and design, and project execution. The regulation is mainly directed towards the client (or the client's representative), and the

project coordinator and responsible designer(s), including regulations for employers and other enterprises. The regulation describes the client's duties and responsibilities in relation to HSE (Arbeids- og sosialdepartementet, 2009).

3.6.2 Regulatory quality assurance and control

The objective of the building control regulation in 1995 (*bygningskontroll)* was to transfer the quality control over to the designers and contractors responsible for the execution. The regulations required internal control, or third party control of design and execution, to assure a qualified controlling process (Kommunal- og moderniseringsdepartementet, 2003). Today, regulation enforces responsible designers and contractors to implement control system in order to document that requirements provided by PBL are fulfilled. Additionally, since 2013, independent, third party verification of critical safety elements in design and engineering work is required. Designers and contractors have to verify their design in order for the building to obtain approval. The independent control enterprise will verify the design work in accordance to technical requirements (*teknisk forskrift*) and permissions. The control includes a final inspection of the buildings (§23-7, PBL; §24-1, PBL; §24-2, PBL). However, the overall process of the building inspections has in many ways remained unchanged since 1995. A project has first to be classified, based on difficulty level and possible consequences in relation to HSE. The responsibility of the building process (from application to deliverance certificate of completion) is given to a qualified enterprise, and the controlling enterprise needs a central permission issued by *Statens Byggtekniske Etat* (Kommunal- og moderniseringsdepartementet, 2003).

3.6.3 Requirements for documentation

The PBL provides requirements for all responsible applicants in relation to the preparation and hand over of the MOM (Management, Operation and Maintenance) documentation at the end of every project. The MOM documentation is handed over to the client at the project completion, and includes all the technical documents generated (drawings and descriptions) in the building project (Statsbygg, 2002). This regulation was implemented in 2010 to enhance the quality in the MOM documentation and requires that the responsible applicant deliver documentation of the structure and quality of the building, together with all information regarding the changes that have been performed during building, installation and testing.

Further to this, the client must first be notified before a *certificate of completion* can be signed by the responsible municipal. However, it does not require the client to verify that the MOM documentation is in accordance with the actual work that was performed, or for the client to update the documentation after a certificate of completion is signed (in the operation phase) (Norsk Byggtjeneste, 2010).

3.7 Other relevant research

The R&D project *Byggekostnadsprogrammet* in 2005 has led to several prominent studies capturing various challenges in the Norwegian construction industry. Meland et al. (2009) mentioned that there had been little literature studies in regards to the construction industry in Norway prior to this project. The R&D project in 2005 generated an array of reports, which have provided this thesis with valuable insight of the construction industry. Further to this, other relevant literature studies have together with the R&D project in 2005 formed a solid theoretical basis for further discussion. It is important to understand that the information presented is selected among several studies and only relevant data is included. Furthermore, the content in this chapter yields only an introduction to the complete research. Please refer to the complete designated study for detailed information.

3.7.1 Poor competence among clients – a complicating factor

Økt kundekompetanse – forbrukerportalen.no/bolig is one of many final reports of the R&D project of 2005. It highlights how client's competence is important to planning, as it lays the foundation for the execution, cooperation, quality, costs, and time perspective of the project, which is also important in the elements regarding operation of the facilities (Forbrukerrådet, 2009). In another study, Meland et al, (2009) share the same findings of Forburkerrådet (2009), by describing how unclear requirements and expectations by causes complications in building projects. The report highlights that when clients' needs and expectations are insufficiently communicated into the project, will occur an incomplete requirement specification for the project management. This increases the probability of errors and omissions. The report states that it is beneficial that clients with insufficient competence seek expert knowledge as early as possible in the projects. Furthermore, Latham (1994) in a report

intended for the construction industry in the UK, underlines that clients who do not understand their needs create a frequent need for changes in the design and engineering phase of building and construction projects. This research also describes how the same issue would lead to increased costs and weaken the project in general.

3.7.2 Planning featuring engineering and design – vital for project success

Meland (2000) states that the framework for engineering and design provided by the client or contractor is the most important element for a successful end result of building projects. He further describes that lacking in quality on various project administrative tasks can have a strong impact on the project's result, and that planning is a major work methodology in order to avoid project failures. Poor support by the client in terms of inadequate timeframes and insufficient economic resources for planning, engineering and design have a significant positive correlation with project failures. This understanding is also supported by the report *Prosjekteringsplanlegging og prosjekteringsledelse* – a part of the R&D project in 2005. The report describes how management and planning of engineering and design are essential for a successful project, in order to influence the project at an early stage when the ability to influence cost is greater. Further to this, another report states that the role of a *design manager* often rank low in various building projects, and describes how the responsibilities of this role can vary, depending on the client's organization model and competence (Arkitektbedriftene, 2010). Meland et al. (2009) further underlines the importance of adequate allocation of time in the early phases of a project, in order to complete detailed engineering and design, and to maintain control before any work can start. The study states that in order to obtain higher quality, one needs to implement more systematic control, particularly in relation to the interphases: design –building, building – takeover.

3.7.3 The construction industry – an industry of gradual development and change

Meland et al. (2009) describes how the building and construction industry has a large element of knowledge-based experience, and that it is receptive to gradual development and change, in which rapid and comprehensive changes are often met with resistance. They further state that there has been a certain transfer of experience from other industries, particularly in relation to quality control, which in Norway involved the introduction of building control

(*bygningskontroll)* in 1995. This required all project participants in the industry responsible for management or execution contracts to have a system for quality assurance. However, the report states that experiences from other industries has provided a basis to conclude that it is insufficient to not only have a formal control system, but that there also has to be a practical compliance of it.

4 The Norwegian petroleum industry

The Norwegian petroleum industry has since 1971 experienced enormous progression in terms of increased investments and activities. High activity have attracted companies worldwide providing the Norwegian maritime industry with valuable knowledge, technology and thus, stimulating the development of a global maritime knowledge hub in Norway (Zhovtobryukh et al., 2013).

4.1 Value chain

Today, Norwegian-based suppliers and contractors cover the major part the value chain. Figure 4-1 illustrates the value chain of the petroleum industry and how it is divided into stages.

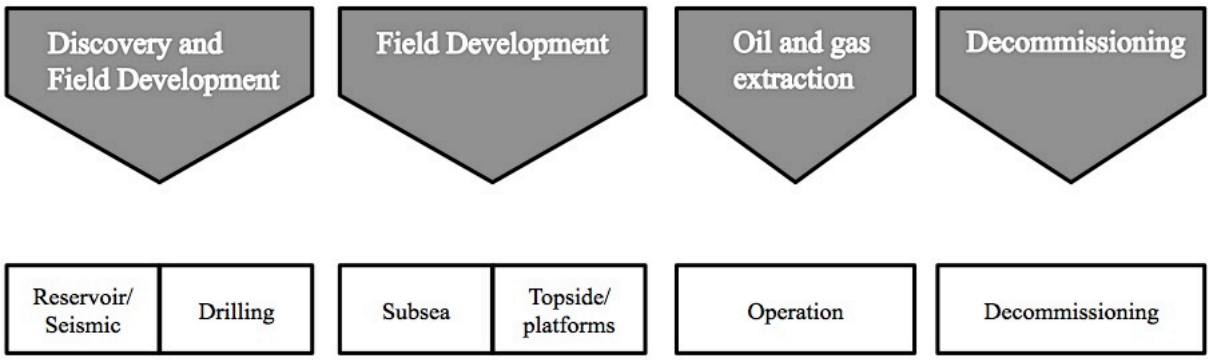

Figure 4-1: Value chain for the Norwegian petroleum industry (Zhovtobryukh et al., 2013)

The NCS consists of 29 companies with production licenses and among these are 13 operators (Norwegian Ministry of Petroleum and Energy, 2002). Statoil is the biggest operator in Norway, responsible for more than 80% of all gas- and oil production on the NCS. The company is partly privatized while the Norwegian Government owns of 67% of the shares (Statoil, 2014). Further to this, the demand of modified products and services by oil and gas operators has generated an industry for around 600 and 800 various contractors and suppliers with business relations to the petroleum industry (Norwegian Ministry of Petroleum and Energy, 2002).

There exist several definitions of a contractor and supplier. The term contractor and supplier are often used in relation to same organization. Zhovtobryukh et al. (2013) define Oil and Gas suppliers as companies providing oil & gas-specific services and/or generic services for use in the oil & gas industry. Statoil (2007) has a rather different definition, and they define a contractor as a provider of the following services: "Engineering (E), Procurement (P), Construction (C) and Hook-up (H)". A contractor and a supplier based on these definitions are considered to be the same organization, and the term contractor will further be used. In this context, the term supplier will be used when referring to an organization providing a product and/or part, e.g. producer, distributor, retailer or vendor of a product (Statoil, 2007).

This research only looks at the topside/platform sub-segment of the petroleum industry (equipment and vessels). There exist numerous service companies who provide vessel services (including ships and oilrigs) as their main business towards operators in this sub-segment (Zhovtobryukh et al., 2013). This business is possible since operators have limited capacity and has to contract the services companies in order to perform exploration and drilling operations. It is necessary to understand that operators also possess their own oilrigs as part of their core business, especially for the licensed oil and gas production fields. In the topside segment, as shown in figure 4-1, operators often become the "end-user" of every vessel (ships and oilrigs) on the NCS. A service company who provide this kind of service is further referred to as rig owner in this thesis.

Operator is a client for rig owners and a potential client for all the remaining contractors in the petroleum industry. Rig owners have the sole goal to win future contracts with operator firms, but in order to do so; they have to perform modifications, maintenance and new construction projects, this creates business for other contractors in the industry. Therefore, rig owners are client for many contractors in the industry as well.

4.2 Project organization

Every contractor has an organizational structure that reflects the business and the service it provides in the market. Figure 4-2 presents a simplification of a project organization for a typical EPC-contractor (EPCI/EPCH).

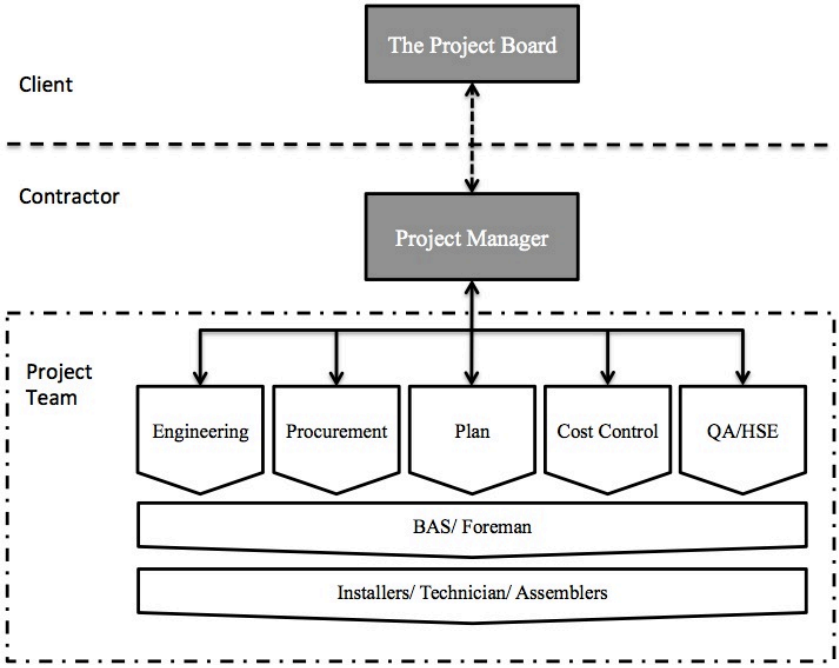

Figure 4-2: Simplified project organization in EPCI/EPCH contracts

The client's project organization usually consists of a project board, which involves all the required discipline necessary for the project. The size, skills and competence involved in the project board are dependent on the type of project at hand. Furthermore, the project board usually holds sufficient competence for decision-making and has the responsibility to monitor and control the project and contractors. The study of project organizations in the petroleum industry has led to the understanding that it can vary strongly, dependent on the company being studied. Figure 4-2 presents a common representation for the petroleum industry, as it seems that project organization in the petroleum industry is close to the descriptions in many project management literatures. Further to this, each role presented in the figure, seems also to have the same job description as mentioned in chapter 2.2. It becomes irrelevant to map every type of organizations, and the project organization above will further form the basis for comparison between the two industries.

4.3 Contract types

Table 4-1 describes the main processes that can be included in a project. The processes (activities) to include in a contract depend on the type of project and the client's preferences regarding the project execution. The client (operator) has the general responsibility that the contractors and sub-suppliers have satisfactory experience and competence to execute the project – that is, unconditioned by the applied contract type This is necessary to ensure a successful project with high quality in all stages, and to compromise the interest of the government when considering the extraction and operation of the production fields.

Table 4-1: Type of contracts in the petroleum industry (NPD, 2013))

Abbreviation	
E	Engineering
P	Procurement
C	Construction
I	Installation
C	Commissioning
H	Hook-up
F	Fabrication

Furthermore, EPCH (Engineering, Procurement, Construction, Hook-up) is often used for topside installations, such as for new oilrig projects. EPCH-contract type gives the main contractor the total responsibility from engineering to installation offshore (NPD, 2013).

4.4 Phases and processes of a project in the petroleum industry

Field development, maintenance and modification operations in the petroleum industry are primarily executed as projects. These projects can further be divided into three phases: (1) initiation and definition, (2) development and planning, and (3) execution and control. Figure 4-3 shows how each phase compromises processes and activities. This has been done in order to provide a basis for comparison with the construction industry. However, others may define the planning and development phase compromising all processes starting from feasibility study to engineering and procurement, such as the Norwegian Petroleum Directorate (NPD, 2013).

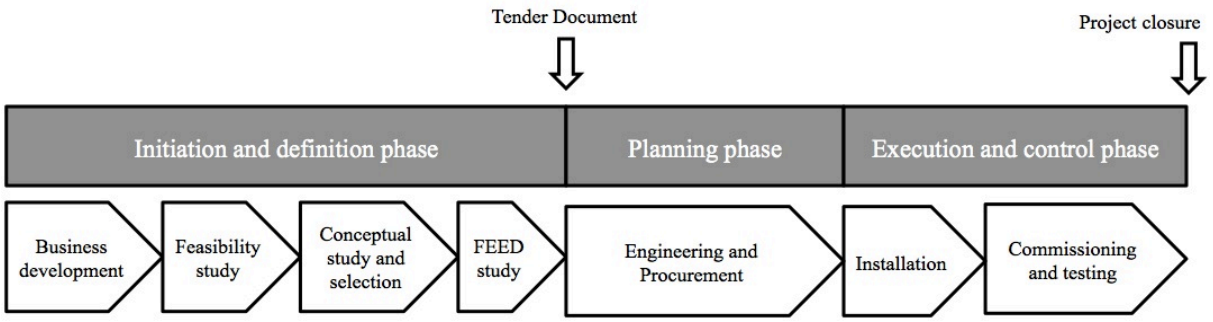

Figure 4-3: Generic project phases and processes of a project in the petroleum industry (NPD, 2013)

Furthermore, the final output of the initiating and definition phase is a Front End Engineering Design (FEED). The client usually develops the FEED either independently or in collaboration with contractors. The FEED is usually developed after the Feasibility study or Conceptual design, and it focuses strongly on the technical requirements of the project. Additionally, it includes an estimate of the project's cost of investment and forms the basis (design) for tender. The preferred contractor enters the planning and development phase after the contract has been awarded. In this phase, more detailed engineering, design and procurement are performed to clarify all technical and commercial presumptions outlined in initiation and definition phase, and to meet requirements defined by the contract. The production and installation can then take place after design and engineering have reached a certain level of maturity (EPCengineer, 2014). The project is considered completed when the Commissioning and Testing is performed, and when all contractual conditions are clarified.

4.5 Regulatory framework and legislation

Various regulatory regulations, requirements, framework and standards compose operations and projects in the petroleum industry on the NCS. *Petroleumstilsynet* is the authority responsible for the supervision of the industry in relation to HSE, technical, and operational safety. The regulations focus strongly on HSE and quality in almost every aspect of the projects and operations. Operators have the main responsibility to ensure that regulatory framework and regulations are being followed in order to operate on the NCS. The rig owners must make sure that all equipment is in accordance with the requirements given by regulatory requirements and standards, in which can become very complex (Petroleumstilsynet, 2014). As to the extensive and complex regulations and standards in the petroleum industry, operators and contractors often include third party classification companies such as DNV GL to safeguard that design, installations and processes, products among several others, comply with yielding standards and regulations (DNV GL, 2014).

ISO certifications and DNV certification seem to be a common approach for many contractors and suppliers in the Norwegian petroleum industry. Contractors can through certifications, demonstrate that the company has management systems that meet the requirements in relation to relevant standards and regulatory framework in the industry. However, the certification process needs to be performed by a third party classification company such as DNV GL. The ISO certifications strengthen the company's systematic work towards improvement, and it is by many clients (operators and rig owners) a requirement. Further to this, the ISO standards specify (among various requirements) that all companies must establish, implement, document and maintain systems for quality control, focusing on continuous improvement (ISO 9001:2008; Wergeland Bedriftsutvikling As, 2013).

LCI (Life Cycle Information) requirements have earlier been based on the NS 5820:1994, which is the suppliers documentation of equipment (Statoil, 2007). An increased number of operators (and rig owners) on the NCS have implemented LCI requirements in projects towards contractors and suppliers in order to enhance the quality in documentation. The objective is to standardize project documentations from contractors and thus improve quality.

However, the LCI requirements specify (in detail) how technical equipment and deliverables should be documented, and some also specify the process of documenting in projects. Statoil in 2009 initiated a project with the objective to standardize technical documentation. This was done enhance operations both onshore and onshore with a long-term focus (Hestnes, 2012). The LCI requirements require extensive control both by client and contractor since, since a project often produces a vast number of documents. Furthermore, client can with the requirements monitor and control that the design and engineering work of contractors is in accordance to the regulatory requirements and project requirements (NCE Systems Engineering Kongsberg, 2013).

5 Research Methodology

5.1 Research strategy

Kothari (2004) states that "research method" compromises all methods and techniques applied by researchers to collect data. However, the objective of the research is not to collect data, but rather use the empirical data to uncover the complex reality that is still hidden. Figure 5-1 illustrates the research methodology applied in this thesis, which is divided into four stages.

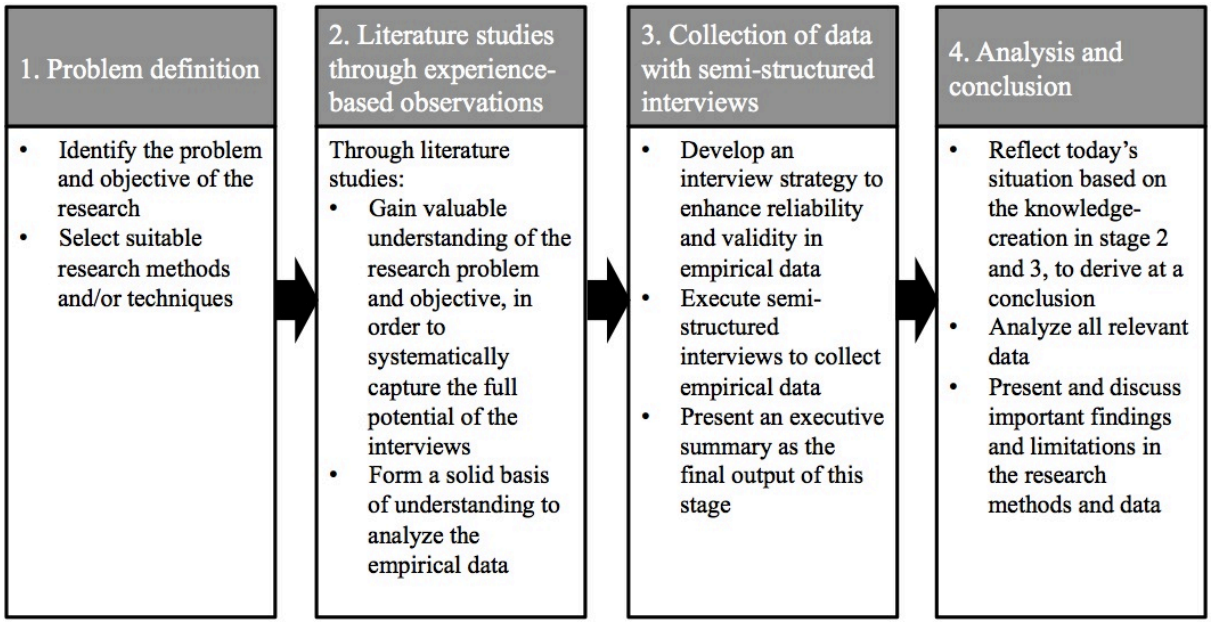

Figure 5-1: Research methodology

The first task is to identify the problem of interest and thus establish an objective for this thesis. However, understand that problem definition is a dynamic, ongoing process and changes to the initial problem will occur all the way as the study continues and new understandings are established. Furthermore, this thesis strongly depends on prior experiences alongside the researchers knowledge, since it will provide the research with valuable secondary information, impossible to capture by only using literature studies. Prior experiences and knowledge expressed as experience-based observation together with

literature studies will form the secondary data of this thesis. Finally, the secondary- and primary data (empirical data) will be analyzed to provide a final conclusion, reflecting the research objective.

5.2 Method selection: qualitative versus quantitative

Qualitative research methods have in the recent years gained more popularity in the field of applied research. Unlike quantitative methods, qualitative methods allow the researcher to be flexible during the research process, and are effective in identifying intangible factors, such as norms, roles, culture, and the experiences of individuals involved in the research (Mack, 2005). Therefore, qualitative methods are suitable for the nature of the problem in this study, as the relationship between a client and the project is complex and "intangible". Table 5-1 summarizes some of the most essential characteristic of qualitative versus quantitative methods. However, keep in mind that these characteristics are no way absolute and variations among approaches exist.

Table 5-1: Qualitative versus quantitative methods (Lilledahl & Hegnes, 2000)

Qualitative methods	Quantitative methods
Flexible approach	Inflexible approach
Gives an overall understanding	Representative overview
In- depth understanding	Wide understanding
Development of hypothesis and theories	Evaluation of hypothesis and theories
Concepts, categories and typologies	Distributions and correlations
Unstructured research process	Structured research process
Non- standardized research methods/ techniques	Standardized research methods/ techniques
Documenting based on citations/quotes	Documenting based on statistics (tables)

Furthermore, the study of the petroleum and construction industries requires a method that can generate a rich amount of data in a short period of time – given the complexity and time constraint at hand. Qualitative methods are more applicable as it is less time demanding and requires less data – that is, qualitative methods are more effective when compared to

quantitative methods, as there exist no applicable quantitative data available (Madrigal & McClain, 2012). In the context of the research objective presented in the introduction, the objective of this thesis is to derive at a complex understanding and a description (theory) regarding the problem, rather than to test a hypothesis. As described by Zhang & Wildemuth (2009), quantitative analysis is deductive and requires random sampling of raw data, and is commonly intended to test hypotheses. Qualitative methods on the other hand, are mainly inductive, in which data is normally summarized into categories or themes based on researcher's interpretations, and thus derive at theories and descriptions.

In short, the advantages of qualitative methods make it suitable and applicable for this research. On the other hand, the disadvantages of quantitative methods make it unreasonable and inappropriate for the research objective at hand. Hence, the exploratory research for this thesis relies on qualitative in-depth interviews as the primary method to obtain empirical data, in which together with literature studies (experience-based observations) as secondary source of information, forming a solid basis for deeper understanding and further assessment.

5.3 Semi-structured interview

There exist three interview structures, all of which makes semi-structured format the most commonly used technique among the following structures: (1) Unstructured interview; (2) Structured interview; (3) Semi-structured interview (Brinkmann, 2013). Thagaard (2002) describes that semi-structured interview can be interpreted as a hybrid structure between unstructured and structured interview. Much alike unstructured, the semi-structured interview follows a predefined plan for the topic like in a structured interview, but does not follow a strict order of questions. The semi-structured format motivates the interviewee to express all possible knowledge on the topic, as the expected answer is not fixed, but rather open-ended (no fixed answers, like yes or no). The flexibility of the method allows spontaneous adaption, as the researcher can immediately respond with subsequent questions on any desired topic during the interviewing process. It ensures that the interviewing process follows a general topic and at the same time enhances extensive knowledge-producing discussions.

The four main themes of discussion in the interviewing process for this thesis are:

1. Planning and development
2. Monitoring and control
3. Project changes

The goal of performing semi- structured interviews is to derive at an executive summary for further assessment. Hence, these themes will later become categories in the summary, as it will give a structure to the interview summary and makes it easier for reader to understand the empirical data.

Appendix C and Appendix D include two interview guides that will be used during the interviewing process as a guidelines, in order to ensure that the semi-structured interviewing process proceed in the desired direction. However, any subject of interest can become the main theme of discussion of any interview, as it is up to the interviewer to decide whether it is of interest for the study or not. The interview guides are two parts: part one is intended for the interviewees and part two for the interviewers. Part one gives a short introduction regarding the research problem, as it includes the overall topic and a description of the objective of the interview and reflects the objective described in the introduction. Part two also contains follow-up questions to ensure that all relevant information is captured. All participants will receive part one of the interview guide prior to the interview, and thus have the opportunity to get familiarized with the themes of discussion. This approach will additionally help increase "systematic involvement" and thus help gain the interviewee's attention and interest, and further increases credibility of the research (Thagaard, 2002).

5.4 Experience-based observation and literature study

As part of the research methodology, literature studies are the secondary source of information. They create a process of thinking that will enable researchers to fully utilize empirical data, and form a foundation for extensive analysis and discussion. It is an important process that enables the researcher to gain valuable understanding of the topic, and thus to continuously challenge primary data (interviewing data) and other information acquired throughout the research. This way, the researcher can apply prior experiences and knowledge

to the learning and analyzing process. The fact that both researchers, one from the construction and the other from the petroleum industries have hand-on experience enables a more constructive and reflective study. Hence, information from literature and interviews will be verified against the researchers personal experience and prior observations. Furthermore, this thesis will try only to include recognized literatures such as textbooks, scientific articles, reports, and master- and doctorial theses.

5.5 Triangulation enhancing validity and reliability

Thagaard (2002) argue that qualitative research carried out on the basis of human interactions as part of the data generation process, is always prone to subjectivity. Hence, she disregards the understanding that qualitative information is gathered objectively and unbiased by personal knowledge and opinions. Thagaard (2002) addresses the need for researchers to systematically approach research with involvement to ensure reliability and validity in data and result. Figure 5-2 presents a simple explanation of these concepts. Reliability is understood as the credibility of information and reflects the researcher' approach of producing data. To achieve credibility, researchers must describe how information is collected, and at the same time reflect the method's limitations and weaknesses, in order to ensure quality in data. As reliability addresses the quality in data, *validity* can be associated with conformability that raises questions directly towards the researcher's interpretation and analyzing process. To ensure conformability, researchers must evaluate and assess the conducted analysis, and be critical about their subjective interpretations throughout the analyzing process. Hence, validity and reliability will be further discussed in chapter 8.2 in regards to other studies and research, which will enhance the reliability of the final outcome at hand.

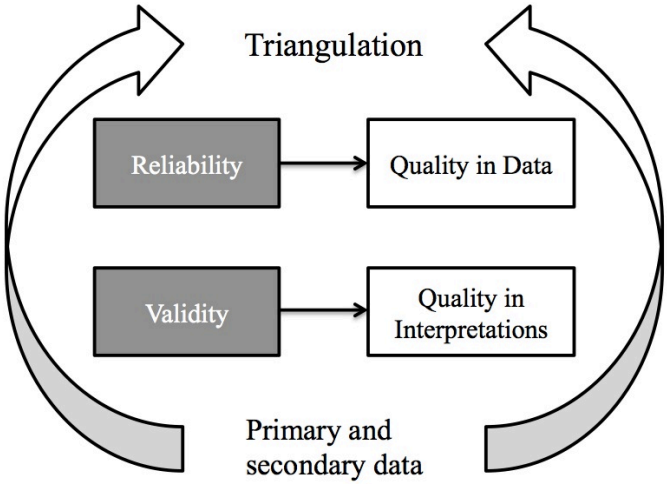

Figure 5-2: Triangulation, reliability and validity

Further to this, another introduced term is triangulation, which is a concept that utilizes different sources of information to enhance and increase the reliability and validity of the research. In this thesis, sources of information will be referred to as primary and secondary data sources. For this thesis, primary data was collected by semi-structured interviews, and secondary refers to information from literature studies and researcher's prior knowledge regarding the topic of study. These sources of information in combination will together be used to increase the credibility of the research (triangulation).

5.6 Interview strategy

The interviewing strategy describes the basis for how primary data is collected and presented, in order to increase reliability and validity of the research in this thesis. The objective of this thesis is to describe how the clients affect the management and the end result of projects. Hence, the chosen interviewees are persons with project management responsibilities and client relation experiences. These candidates are preselected on the basis of their position and work experience.

The interviewees are candidates from:

1. Contractor firms from both the construction industry and petroleum industry
2. Consulting firms often hired by clients in the construction industry

The intention is to gain information around the clients and the project practices in the construction industry and the petroleum industry, and only candidates from contractor and consulting firms are interviewed. A major reason for this is that these candidates have many years of experience and are exposed to various clients. Their descriptions will provide this study with a general impression regarding clients in respect of their industry. Furthermore, the interviews are performed on the basis of personal experience rather than company specific factors. However, relatively recognized companies of each industry are chosen.

All interviews will be performed in Norwegian, as it is the native language for all participants. Citations will be used for documenting and will help aid the reliability of data (ref. Table 5-1), and all interviews will be audio recorded to enhance reliability. Citations will be translated from Norwegian to English as objectively as possible. Furthermore, the interview summary (empirical data) summarizes and highlights the most important aspects and presents a contextual generalization that will provide the reader with adequate understanding of the collected information. Further questions and inquiries will be carried out by e-mail or phone.
It is recommended to see the interview summary in chapter 6 with respect to the interview guide in Appendix C and Appendix D.

Furthermore, 11 interviews have been performed in relation to this research, in which six interviewees represent the construction industry and five are from the petroleum industry. The 11 interviewees constitute eight companies in total – that is, four companies from the construction industry and four companies from the petroleum industry. A list of interviews is presented in Appendix B.

6 Empirical data

6.1 Planning, engineering and design

Interviewees from both industries have understated the importance of comprehensive planning and how it is essential for a project's success.

Projects that have fewer accidents and building faults are completed within time and involve little change-related work. I believe that 85-90% of the reason for a successful project can be linked to good planning, as well as follow-up and control routines throughout the project"

Interview object C (C, P)

"If you don't have a plan, you don't know to what degree you deviate from it, and a detailed planning is necessary to detect changes"

Interview object G (C, P)

However, several have mentioned that a common problem in the construction industry is that many projects are executed in the absence of satisfactory planning and crucial studies (i.e. geotechnical studies, site inspections etc.), all of which is due to inadequate time and resource allocation for the project, set by the client. Some have related the problem to traditional practices and/or cultural challenges, while others mention it as a result of time-pressure and client's desire to see physical progress.

"Often, you start planning before you actually know what needs to be done, which I feel is much of the challenge in this industry. You don't use sufficient amount of time prior to the planning to figure things out, as a foundation for the plan"

Interview object B (C)

"The effect of good planning is that you minimize risk, but with too much planning, you become less flexible and agile"

Interview object A (C)

Several interviewees also mentioned that parallel design and building is a common practice in order to reduce project's duration, and that big overlaps between design and production processes is usually a problem in the construction industry.

"We try to design as much as possible before we start building, but this is probably where the construction industry has its biggest potential for improvement: complete the design before starting to build, to get less deviation and to do things the right way the first time"

Interview object H (C)

All interviewees from the petroleum industry stated that detailed planning is essential in order to execute high quality operations and maintain a high level of safety (HSE). Some have also mentioned the logistical challenges offshore in relation to poor access to materials and equipment. They underlined that if critical elements have been missed out in the planning process, can lead to major consequences later.

"In the petroleum industry, there is a great culture for spending money on studies before engineering, as well as to invest time in planning"

Interview object G (C, P)

"All of our projects have a high level of uniqueness, especially in maintenance and modification projects, where you have to start from scratch and customize solutions every time"

Interview object F (P)

Further to this, a majority of interviewees from the construction industry said that a common mentality in the industry is to solve issues and changes consecutively, "on site", during the building process.

All interviewees from the petroleum industry mentioned that WBS is always performed to break down work activities into processes and work packages, which in detail describes what work to be performed by workers. For the construction industry, it was mentioned that WBS is also used as a planning tool, but general construction drawings and building standards often constitute work guidelines, instead of work packages. Interviewees from the petroleum

industry stated that 3D modeling is an important tool in the design process, especially for large topside construction projects i.e. platform, living quarters etc. Furthermore, interviewees from the construction also underlined that 3D modeling tool BIM (Building Information Modeling), has also become an important and standard tool for design in the construction industry. However, few interviewees mentioned that even though a BIM- model exists, the reversal process of updating the model during project execution is often insufficient, and improvements are stated to be necessary. By contrast, it was mentioned that the petroleum industry has well-implemented routines for model updating because of strict project control.

In the construction industry, a majority of interviewees shared the understanding that cost and time respectively seem to be the most important priorities for the client, but when it comes to quality, a "good enough" mentality dominates the industry. It was said that clients often have poor knowledge regarding the product or fundamental project management aspects, but that some property developers (private and public) often have better experience and project understanding. By contrast, interviewees from the petroleum industry mentioned that clients prioritize quality and time above cost. Several interviewees underlined that operator exceptionally has a strong focus on quality, but that rig owners have a stronger focus on cost rather than quality only. However, clients have a general high competence level, and they clearly have high expectation for the execution of the project and it's deliverables.

"The focus is in most cases cost, but you can see that there is a there has developed a shift towards better quality also in the construction industry"

Interview object H (C)

"Clients are focusing on quality and time – where quality is most important, to avoid future costs and critical consequences of errors"

Interview object D (P)

6.2 Monitoring and control

For both industries, interviewees described that the frequency of reports and status meetings as well as the contents can vary depending on the project and client. In the construction industry, status meetings are performed at the same frequency as the reports, in where more

detailed information is given at the meetings. In the petroleum industry, interviewees stated that general reporting is performed through IT-systems, and status meetings are performed at a different rate. It is mentioned that additional reporting on progress and changes is a common practice.

Furthermore, interviewees described that most clients in the petroleum industry seem to have well implemented monitoring and control systems, particularly in relation to quality assurance, in order to maintain a desired level of quality, and to minimize risk in all phases of the project. It is mentioned that all engineering work and design performed by contractors need to be verified by the client before any work can start, and that clients provides contractors with strict guidelines. Several interviewees also mentioned that many clients often apply LCI requirement for all documentation, in which is also used as a quality assurance tool. Further to this, work packages often have signing protocols to assure adequate quality. There are different conceptions among many interviewees regarding the level of control, in whether they are sound or too rigid and/or time-consuming.

"The quality culture, including HSE, has come way further in the petroleum sector than in the construction industry. The construction industry has also seen improvements, but the compliance is not as good"

Interview object G (C, P)

It was mentioned that the majority of clients in the construction industry have lacking control systems, and are relying on minimum regularly requirements only. However, it is mentioned that public property developers and some clients are more focused on product quality. Public developers are mentioned to often implement more rigid control systems.

6.3 Project changes

All interviewees from the petroleum industry have explained that most changes arise within the engineering phase of the projects.

"The biggest changes normally arise in the engineering phase. If the project basis is good, then issues are detected earlier - incomplete project basis and solutions normally cause the most critical type of changes"

Interview object F (P)

Some mentioned that changes are often initiated by the clients, while others refer to incomplete elements in the project basis as the most common reason for changes. Further to this, changes as a result of inadequate project basis and description are mentioned to be the most critical type of changes for offshore projects.

The majority of the interviewees from the construction industry stated that most changes occur in the building phase of the projects. Further, it is mentioned that client-initiated changes are the most frequent type of changes. Many have also said that these change-order requests are often initiated late into the project, which is a great challenge for the contractors. Numerous examples are given, in where clients have initiated significant changes late into the building phase, leading to substantial economical consequences.

"When the project has started to materialize, the clients often come up with additional wants and needs. Of that reason, it is important to let the client know how long they can make changes without great consequences"

Interview object B (P)

Further to this, several have mentioned that in projects executed for property developers, the end users are often introduced late into the building phase, giving additional challenges for the contractors. However, there is a general consensus among interviewees that poor project basis normally gives the most critical changes, and that insufficient planning often leads to such changes. Many have related this to time pressure, and the clients' desire to see physical results.

7 Results and analysis

7.1 Introduction

The research subject at hand is very complex and multiple dependencies make it difficult to capture the overall picture. Figure 7-1 provides a graphical illustration of the dependencies and will enhance the overall understanding. On the basis of the empirical data, this chapter will provide an in-depth analysis leading up to the several findings and understandings. Furthermore, each sub-chapter will also provide a key findings chapter summarizing the most important findings.

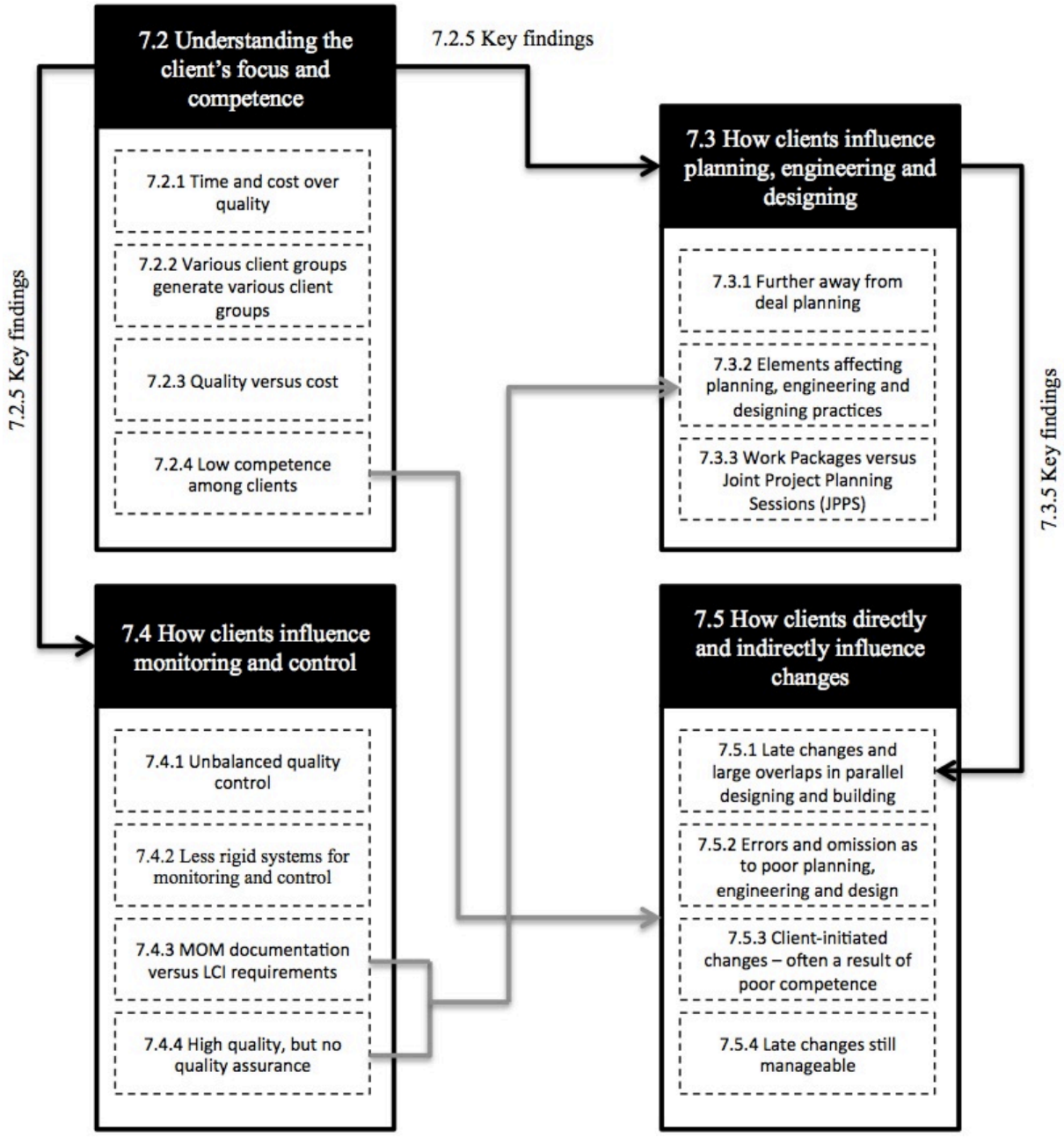

Figure 7-1: Dependencies of the findings

7.2 Understanding the client's focus and competence

Project success is often measured in terms of completing the project within the constraints: time, cost and quality, which are given by the client (ref. chapter 2.1). It is vital for the project manager and team to identify the client's priorities before the project starts, in order to balance the project accordingly to the given constraints and make necessary trade-offs when problems arise.

7.2.1 Time and cost of quality

"For building projects, it is all about finding the golden section to satisfy the client's need, where price and time are often the main focus".

Interview object A (C)

This statement, among others, underlines the importance to identify and determine the project constraints in building projects. The general impression is that clients' priorities vary within each of the two industries. However, in most building projects, cost and time respectively seem to receive the highest priority among clients.

By contrast, clients in the petroleum industry seem to prioritize quality (both process and product) and HSE above both time and cost.

"The client in the petroleum industry has zero tolerance in relation to quality and HSE".

Interview object E (P)

The majority of interviewees referred to quality and HSE as the same, but for the purpose of simplicity, HSE is always included when the term quality is mentioned in this thesis. Further to this, several interviewees mentioned that time is in most projects also highly prioritized by the clients in the petroleum industry. However, clients may demand strict project schedules as a result of time-pressure, or a strong focus on cost, the general impression is that quality always receives highest priority among clients in the petroleum industry – that is, above cost and time. Figure 7-2 illustrate the general focus among clients in the two industries.

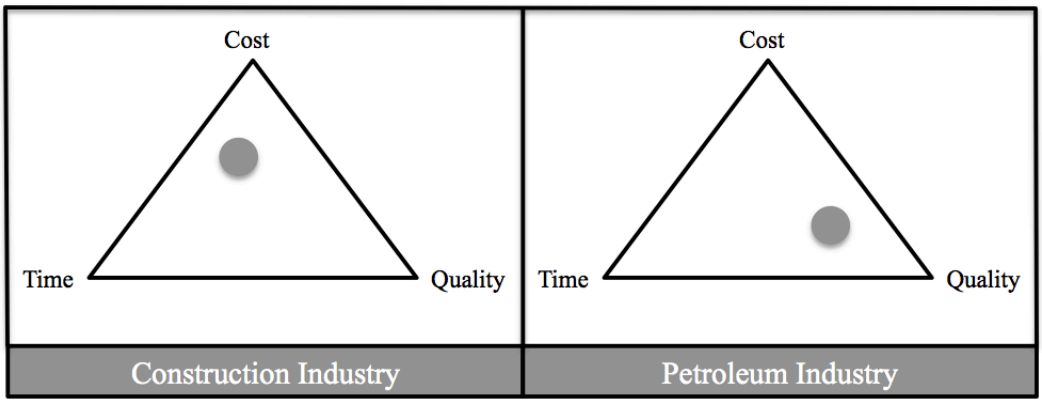

Figure 7-2: General focus among clients in the two industries

7.2.2 Various client groups generate different focus

Whether or not the client is the end user of the project or has MOM-responsibilities influence the clients' priorities in the construction industry. Clients can execute projects for various reasons. As a result, three client groups are defined in order to address the client's focus in the construction industry:

- **Client group 1:** execute projects in order to use the facilities themselves, and to serve their own business purposes and/or needs (typical one-time clients)
- **Client group 2:** execute projects for sale or rental purposes (private property developers)
- **Client group 3:** execute projects on behalf of the government in order to serve the public's needs. In addition, client group 3 is also responsible for MOM (public property developers)

Table 7-1: Client groups and focus

	End user	MOM-responsibility	Quality focus
Client Group 3		X	High
Client Group 1	X		High (depend on competence)
Client Group 2		(X)	Low

Table 7-1 illustrates the various client groups and it is arranged in accordance to the degree of focus the client group has on quality. For client group 1, it is the end user of the project, and the value of the project lies in the operation of the final building or facility, and higher quality

solution may give benefits or value later in the operation phase (less maintenance cost, higher performance etc.). Quality becomes slightly more important to client group 1. However, many clients in client group 1 may not have a strong quality focus despite this fact, since some clients fail to understand that quality is important in the long-term manner. This has to be seen in relation to their technical understanding, in which is further discussed in chapter 7.2.4. With similarities, client group 3 has the strongest quality focus among the three, as a result of the MOM responsibility that it has. However, client group 3 is not the end user of the final building or facility, as it is for client group 1. Figure 7-3 illustrates how the focus of clients being the end users or having MOM responsibilities move towards quality.

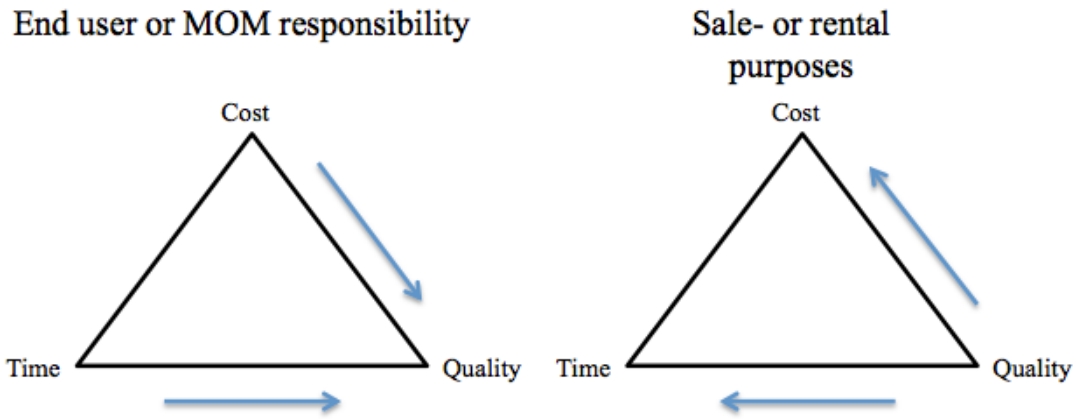

Figure 7-3: Movement in quality focus

As illustrated in the figure, client with sale- or rental purposes have a slight different focus.

"For property developers, it is often important to get the projects executed in a timely matter in order to cover up the building expenses"

Interview object C (C, P)

This statement seems to be applicable for private property developers, as the building process is just another investment cost for these clients and provides no value creation until the facility is sold or rented. Therefore, cost and time naturally receive the highest priority, since private property developer's objective is to ensure higher margins and focus less on the operational aspects. This shows that there exists a slight variation between the three client groups, although both public and private property developers execute projects on a professional level as part of their core business.

7.2.3 Quality versus cost

Several interviewees mentioned that rig owners often execute projects with lower focus on long-term solutions than operators and have a rather strong focus on cost .

"Rig owners often have a rather short-term focus, and often operate on lowest possible requirements as long as they meet the quality requirements given by the operator along with regulatory requirements."

Interview Object G (C, P)

Given the statement above, this can naturally be seen in relation to the fact that operators are the end users of the project, while the rig-owners only provide service to ensure future income, with similarity to private property developers in the construction industry. Hence, rig owners preferably prioritize cost and time in order to maximize their own profits, often at the expense of quality. Operators desire quality with a long-term focus to enhance proficiency in the operations. However, keep in mind that rig owners must satisfy operator's requirements and regulatory requirements. Rig owners will be influenced by the operator's strong focus on quality and strict regulatory requirements, all of which demand a high quality standard in projects although they have a slight different focus.

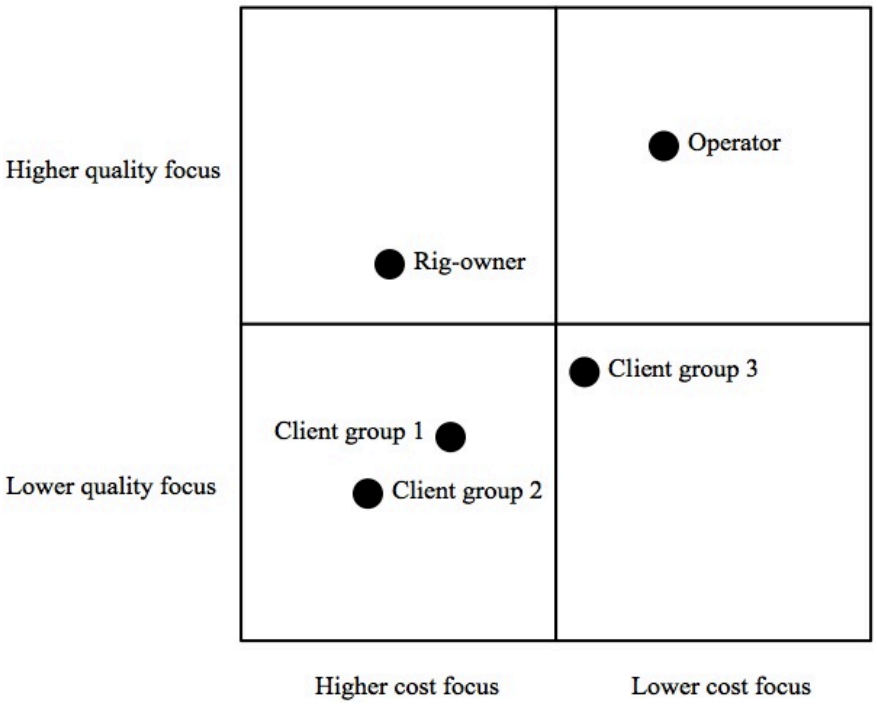

Figure 7-4: Quality-cost matrix

Figure 7-4 illustrates the focus on quality and cost of clients in the two industries. Note that time has not been included in the figure, despite the fact that time can be of great importance for numerous clients in both industries. However, the project constraints form a triangulating relationship between cost, time and quality. High focus on quality and cost will therefore require more time. Furthermore, as mentioned for operators and rig owners, time also has high priority as to the economical importance of the operations offshore. However, It is difficult to provide a general understanding of time, as it is project specific and can vary a lot.

7.2.4 Low competence among clients in the construction industry

The general impression from the petroleum industry is that operators and rig owners have higher competence. It enables the organization to manage and follow-up projects themselves, by having own professional representatives as part of their main organization. They have through many years of experiences with endless operations and execution of numerous projects, acquired comprehensive competence in terms of technical understanding and project management knowledge. This competence has created a good understanding of quality. Operators exceptionally have the understanding that quality is necessary in order to enhance steady operations offshore and to maintain long-term proficiencies. There is no doubt in the understanding that clients (both operators and rig owners) in the petroleum industry have a much stronger focus on quality than clients in the construction industry, as a result of their competence. However, keep in mind that physical and environmental conditions offshore together with strict regulatory requirements also play a key role in the quality focus in the petroleum industry today.

"It often shows that the client's basic knowledge is insufficient in relation to the framework given by the client. The client is normally clear about their priorities on time, cost and quality, but they do not always seem to comprehend the relationship between the three. You often see that the budget does not align with the project timeframe, which in turn affects the final quality".

Interview object B (C)

Higher competence will strengthen the understanding of project constraints, in which the client can provide a more realistic relationship on cost, time and quality, and framework for

projects and contractors. It appeared from the interviews that clients from the construction industry often have lower competence compared to clients in the petroleum industry. However, property developers (both public and private) often have higher competence compared to client group 1. They have their own professional stab of representatives to manage the projects and have usually executed numerous of project in the past. With similarity to the petroleum industry, property developers have over time acquired extensive project experiences and knowledge on projects. Hence, property developers have a better understanding of project constraints than the majority of clients in client group 1. However, it does not necessarily mean that a stronger focus on quality, as it depends on the client's main objective. It is likely that private property developers will be able to maintain a realistic balance in relation to the project constraints and meet the end users' needs and requirements, and also to ensure good margins. Clients who lack this knowledge usually expect unrealistic results.

Further to this, it is unlikely that clients in client group 1 have the same competence than the other client groups, since the majority has less project experience. In particular, clients who execute a project, as a one-time event, will have lower competence compared to professional property developers. These clients usually hire consultants to manage the projects on their behalf, as they often possess insufficient skills in order to manage and follow-up the building project themselves. However, it has been mentioned that this often depends on the client's business, whether they chose to manage projects themself or to hire professional assistance. Interviewees described that that smaller businesses frequently manage their projects themselves and thus become a challenge to contractors if their competence is limited, especially for larger and more complex building projects. Further to this, several interviewees from the construction industry underlined that clients in client group 1 may desire high quality standards, and that they find it important to get the quality they have paid for. It is indicated that numerous clients do not seem to understand how they can enhance higher quality. Many do not seem to provide any specific framework for quality control. Furthermore, they do not set realistic constraints in order to meet the demanded quality requirements at hand.

7.2.5 Key findings

Clients in both industries will influence projects through their focus on cost and time, or quality, and secondly their competence. Clients from the petroleum industry have a generally

strong focus on quality, in which time is also important. However, quality will always have the highest priority even at the expense of time and cost. Clients from the construction industry on the other hand, have a stronger focus on cost and time, often at the expense of quality. Public property developers however, have the strongest quality focus among all the three client groups. Furthermore, interviewees emphasized the understanding that the construction industry is composed by various client groups, leading to different priorities and competence among clients. Clients with higher competence often have a better understanding of project constraints, and thus are able to provide more realistic framework and requirements for the projects and contractors. Public property developers seem to have the highest competence level among all the three client groups, while client group 1 has the lowest competence in the construction industry.

7.3 How clients influence planning, engineering and design

Planning reduces uncertainty, increases understandings and improves efficiency, and thus forms the baseline for project control (ref. chapter 2.4). A good plan is an important tool for the project manager, and it is in addition crucial for the project team to complete the project within cost, time and quality. It is essential to recall on the distinction between "planning" as in "planning and development phase" or as part of the five-process group. In reality, planning (process group) can be performed in any project phase and is not limited to the planning and development phase only. However, a majority of contractors may consider engineering and design (and procurement) activities as the main "planning" tasks of a project (after receiving the contract), since primary baselines and solutions for the project are developed in this phase. The term "planning" will further be used to address the five process groups, unless it is specifically stated otherwise. Further to this, procurement is also an important activity in the planning and development phase in the petroleum industry, and the term "engineering" will therefore include procurement. Hence, engineering and design will therefore include every activity under the planning and development phase. Chapter 2.3 describes the five process groups in more detail. Figure 7-5 will helps illustrating the planning and development phase for a better understanding.

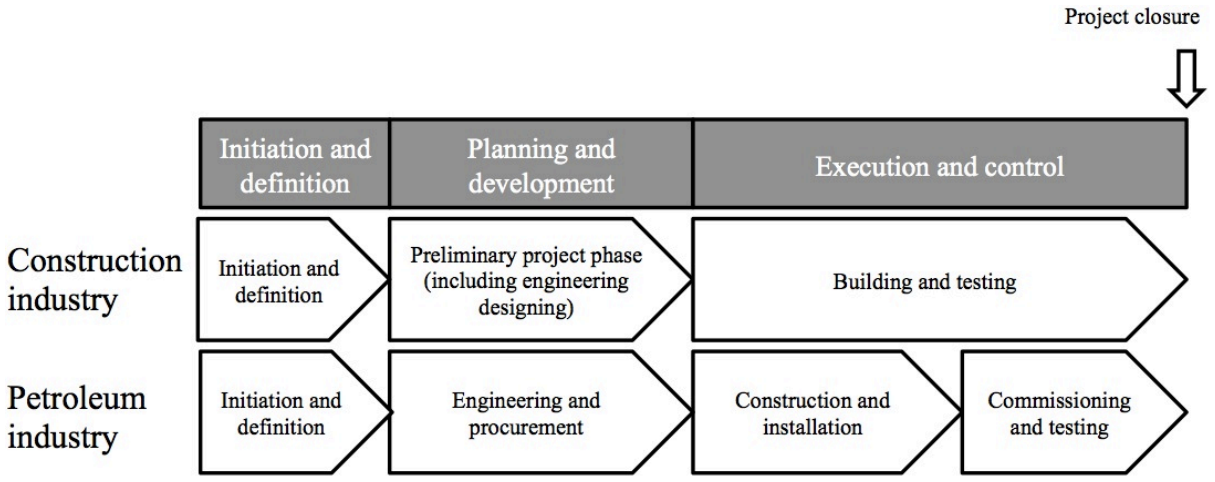

Figure 7-5: Comparison of project phases

7.3.1 Further away from ideal planning

Interviewees from the construction industry stated that too little resources allocated for engineering and design activities before the building process often places a major risk and uncertainty on the end result of many projects. Several interviewees underlined that insufficient engineering and design work is a well-known and recurring problem in the construction industry, leading to extra cost overrun that initially can be avoided with more detailed work. There is a general consensus among interviewees from the construction industry that this problem could be a result of time-pressure, but also partially because of strong traditions and habits among contractors. By contrast, the highly regulated Norwegian petroleum industry is renown for its strong focus on quality and HSE, and has as a result long tradition in implementing advanced engineering- and management systems in order to enhance higher performance and to provide reliable solutions. A general perception is that clients and contractors in the petroleum industry often allocate a considerable higher amount of resources into planning, engineering and control. Hence, extensive planning and engineering play a major role in offshore projects. Detailed planning and engineering are also expected and thus have become a common practice among contractors in the petroleum industry as well.

"*There exist a totally different regime in the petroleum industry regarding planning and engineering, in which the petroleum industry is way more extensive*".

Interview object C (C)

Based on several statements in the interviews, numerous construction projects seem to rather follow the pain distribution of poor planning, all of which is the opposite of what Wysocki (2009) suggests (ref. chapter 2.4). Hence, there is no doubt that the highly regulated petroleum industry is far more mature in the field of planning and engineering. Although this is a reality, this thesis cannot argue whether or not planning practices in the petroleum industry are comparable to the practice of an ideal project. Since project failures in both industries have made it to the headlines of several news articles in the past.

7.3.2 Elements affecting planning, engineering and design practices

In order to provide an in-depth discussion on the contrasting reality between the two industries, the following three influencing elements are introduced for further assessment:

(1) The client's competence and focus on time, cost and/or quality, influences the degree of planning, engineering and design in projects, in both industries, especially whether or not the client has a strong focus on quality (including HSE) is a crucial, influencing factor
(2) Cultural differences exist between the construction industry and the petroleum industry, all of which unconsciously separate and influence the general project management practices and quality mentality among contractors and suppliers, leading to various planning, engineering and design
(3) Strict regulatory requirements and standards in the petroleum industry require projects to be performed with a high level of quality (including quality control), all of which is achievable with detailed planning and engineering. By contrast, less regulations and standards in the construction industry lead to different planning and design

Up to this point, there is no doubt that clients from both the petroleum industry and construction industry have the ability to influence projects, by establishing framework and project requirements, all of which contractors and suppliers have to govern. Furthermore, the client on one hand and regulatory requirements on the other hand, dictates the execution process and how contractors approach the project. First, contractors must govern the client's need and demand (time, cost and quality), but at the same time satisfy regulatory requirements

and standards, in order for the project to gain approval and thus become successful. However, among other factors, clients strongly influence the potential outcome of a project.
It is important to recall on the following findings from chapter 7.2.1, regarding clients' focus:

- Clients in the petroleum industry (operators) often prioritize quality over cost and time
- Clients in the construction industry usually prioritize cost and time over quality

In a project where the client has a high quality focus (both process and product), the project undoubtedly requires a higher level of planning. Clients and contractors in the petroleum industry seem to share the understanding of this dependency, as it is reflected in the common practice and the degree of planning and engineering utilized in projects and operations (also mentioned earlier in this chapter). Furthermore, projects offshore is often characterized by high risk and complexity, in which deliverables are specialized, and consequences of the project failing in the execution and control phase can lead to severe cost overruns and delays. Hence, for both clients and contractors, project failure offshore must at any cost be avoided, as failure concerning critical safety systems is a threat to personnel offshore and the surrounding environment (HSE). Both clients (operators) and the Norwegian government have implemented strict regulatory requirements (including HSE), framework and standards in order to safeguard high quality and safety for both onshore and offshore activities, all of which is motivated by the physical and environmental conditions mentioned above.

"The cooperation and the distance between an engineer in the petroleum industry and a worker offshore is rather short and effective. The planning and engineering work for offshore projects are extensive with detailed drawings and procedures for almost everything versus characteristics drawings in the construction industry, which is much less in detail. This way, if you are offshore and you are missing parts, equipment and/or information, engineers onshore will always receive quick feedback, since access to additional equipment offshore is difficult. Planning and engineering is extensive in the petroleum industry because of these reasons and consequences offshore, always do it right the first time".

Interview object G (P, C)

However, in chapter 7.2.3 it was mentioned that rig owners might have a slight different focus than operators in the petroleum industry, and the remaining contractors will also have the same objective as operators (secure margins). Despite this fact, the general impression is that contractors in the petroleum industry usually have a strong focus on detailed planning and

engineering (and control) as a result of harsh physical conditions offshore and strict regulations. Essentially, both because it is required by the client and defined in regulatory requirements, but also by own initiative – since it is profitable. Physical conditions in combination with higher cost rates offshore, have made it more profitable for contractors to perform detailed planning and engineering early onshore (lower hour-rates than offshore) to reduce risk and uncertainty, and furthermore to avoid changes. The objective is to perform as much planning, engineering and constructing as possible, before the installation offshore. Hence, both clients and contractors share more or less the same knowledge regarding the nature of the project, and thus motivate a joined quality mentality, leading to extensive planning and engineering practices. On the other hand, clients in the construction industry largely prioritize cost and time over quality and thus influences projects differently. The majority of the interviewees from the construction industry mentioned that parallel engineering and building is motivated by persistent time-pressure and is a common challenge for contractors in the construction industry, making it difficult to perform necessary planning before building. This can be led back to the fact that clients may not see the benefit of detailed planning, engineering and design. Client is rather focused on seeing progression and results. Additionally, a client with poor understanding of the project constraints will think that complex projects do not need more detailed planning, leading to even lower allocation of resources and time for planning and design activities.

" Engineering and design can be performed in parallel with building as a result of time-pressure, in where only the critical technical elements are frozen"

Interview object H (C)

However, time-pressure alone does not lead to less focus on planning and design work, as it is a reality in both industries. The reason for why contractors in the petroleum industry have a stronger focus on planning and engineering, is believed to lie in the project management landscape, and it can be seen as the resulting combination of the following factors:

(1) High quality focus on both process and product among clients forms a solid basis for more detailed planning and engineering

(2) Strict regulatory requirements towards quality and HSE, motivated by physical conditions offshore demand detailed planning and engineering
(3) Both clients and contractor share the same understanding that detailed planning and engineering are profitable for the project as of the conditions offshore

These three elements show how the execution of projects in the petroleum industry differentiates from the construction industry, leading up to different planning, engineering and design practices. It becomes irrelevant to illustrate all the differences in practices, given the objective of this thesis is to study the influence clients have on planning and engineering, and such a comparison will lead to no end. However, some major differences will further be described in order to illustrate the big contrast between the construction industry and the petroleum industry in the way projects are being executed.

7.3.3 Work packages versus Joint Project Planning Sessions (JPPS)

In the petroleum industry, each activity on site (performed by a worker) requires a work package (ref. chapter 2.4.1), and engineers and/or specialist (planners, job-setter etc.) normally prepare the work packages. These work packages contain all the information needed by a worker in order to perform the job, i.e. detailed drawings, how-to procedures, list of material (describing length and size), labels etc. This document is handed from the BAS (foremen) to the workers and can be applied to any type of works such as pulling cables, welding, installation of equipment etc. Hence, the work package describes in detail how the job must be performed, and it usually requires detailed planning and engineering. The actual work must then be reported in drawings as red mark-ups, in order for engineers to complete the final documentation, and is also used to report progression. By contrast, no interviewees from the construction industry have mentioned a similar practice to work packages. However, a majority mentioned that JPPS (ref. chapter 2.4.2) and standard drawings are common practices in the construction industry. Meetings assemble all the concerned technical personnel of the project, such as the project manager, discipline leaders, and foremen etc. to discuss the upcoming building process. The topic of these meetings is to plan the building process, as the objective is to meet cost and time constraints at hand. Further to this, several interviewees mentioned that these meetings would give all participants an ownership of the plan, and thus motivate higher performances. With the given plan, the discipline leaders (and foremen) can then allocate tasks to workers, but no work packages are handed over, only

verbal instructions and standardized drawings. This contrast illustrates the gap between the two industries. The petroleum industry on one hand invests a lot more resources into the development of detailed drawings and work packages to ensure quality and traceability. The construction industry on the other hand, utilizes verbal instructions and standard drawings as the basis for building activities. Understand that these drawings a far from detailed, and is more or less similar to a guideline of "how it should be like".

Nevertheless, this does not provide any basis to conclude that contractors in the petroleum industry have higher competence, but rather state the fact that project management has gained too little attention both among clients and contractors in the construction industry, which has led to various planning, engineering and design habits.

"In several projects, I feel that if we had put a couple of more months to planning and design, and delayed the production – the project could have been completed in less time. This has been proven in some projects, which spent more time in planning before started the building process".

Interview object H (C)

Furthermore, there is no doubt that several clients and contractors in the construction industry may not see the benefits of detailed planning and design, and often rush into building before the project is ready. As mentioned earlier, part of this reason can be led back to the client, but it does also depend on the contractors. For contractors, this can be the result of traditional practices in combination with the desire to see physical results, in which the last mentioned, yield both the clients and contractors. Less demanding project conditions onshore also give contractors more flexibility in the execution phase than for offshore projects in the petroleum industry. The planning, engineering and design practices among contractors can thereby be seen as a resulting combination of the following factors:

(1) A strong focus on cost and time among clients, leading to less planning and design
(2) Less regulatory requirements and standards in relation to quality and HSE leads to lower focus on planning and design
(3) Project conditions onshore gives contractors more flexibility and a fewer reason to perform detailed planning, engineering and design

7.3.4 Key findings

Clients undoubtedly influence the degree of planning, engineering and design in projects through their competence and focus on cost, time, and quality. Differences in regulatory framework and requirements within each industry also influence the degree of planning, engineering and design utilized in the projects (These practices). Clients and contractors in the petroleum industry seem to allocate a considerably higher amount of time and resources into detailed planning and engineering as to challenging physical conditions and regulatory framework. This enhances project quality and minimizes re-building work in the installation process offshore. A different mentality and traditional practices exist in the construction industry, all of which influence the amount of resources client and contractors allocate into the planning and development phase of building projects. Less strict regulatory requirements do along with higher flexibility onshore leave clients and contractors in the construction industry with fewer motives for detailed planning and design.

7.4 How clients influence monitoring and control

As mentioned in chapter 2.5, monitoring and control are essential in the process of detecting deviations from the plan, and to make necessary changes when the project is unbalanced in relation to the given constraints (cost, time and quality). Processes for monitoring and control will normally reflect the clients' focus on quality, in which close follow-up routines will provide better quality assurance (both product and process). Control is necessary for both client and contractor in order for the project to run accordingly to the plan, and to ensure that the project meets, clients' need and quality standard, and regulatory requirements.

7.4.1 Unbalance in quality control

The interviews have provided this thesis with valuable insight to underline that there exist various differences between the two industries in both the degree and way projects are being monitored and controlled. Keep in mind that various monitoring and control practices exist within each industry and are dependent on the client's- and contractor's organization.

Strict regulations and harsh conditions offshore require a strong degree of control, leading to the development of rigid control systems and routines that exist within almost every organizations in the petroleum industry today. Similar to the understanding regarding planning and engineering, the petroleum industry allocates a considerably larger amount of resources into monitoring and control practices compared to the construction industry. By contrast, several interviewees from the construction industry pointed out that the degree of control utilized in building projects often depends on the client, all of which the level can vary strongly with each building project. Some clients want strict control, while others do not seem to see the benefit of tight control. However, the degree of control must reflect the project's characteristics and conditions at hand. Too little control disables the project to see potential threats, while exaggerated control can limit the ability of the project to reach the objective, and will only add unnecessary cost to the project. A balanced level of control will provide the project with optimal results, which in fact is difficult to determine. Hence, it becomes inappropriate for building projects to implement the same level of control as in the petroleum industry, since the nature and characteristic of building projects are very unlike. Several interviewees argue that too little quality control in many building projects can lead to various building faults and errors after project's closure, which is common in the construction industry. This finding indicates that there exists an unbalance in the degree of quality control utilized in building projects, favoring for too little control. By restoring this balance, building projects can benefit from higher performance and improved results. Understand that control can be utilized on several aspects of the project, and it often reflects the client's priorities on cost, time and quality. As time and cost often receive high priority among clients in the construction industry, reporting routines seem to reflect the client desire in building projects – that is, cost and progress reporting is of highest importance. Quality control on the other hand, seems to have received less attention, most likely by both client and contractors.

"A main challenge is what level of control the client wants. Many doesn't see the benefits of tighter control, while some know that money invested in better control systems gives payback in many ways".

Interview object B (C)

This statement can be seen in relation to the variation in competence among clients in the construction industry, and the fact that many client groups has generated various view and

understanding regarding quality control, not to mention various priorities on project constraints. Contractors must with each project adjust the level of control and its routines in order to meet the client's requirements and desire, all of which is a challenge in the process of finding the perfect level of control. A contractor will most likely not implement higher control than demanded by the client if it is not supported economically, which understates the negative effect it will have on the quality of the output. The fact is that both client and contractor may benefit from better control, but the problem is for the clients to understand the benefits it can provide the project. Contractors can enhance higher margins as project constraints and requirements are met, and client will most likely receive the quality standard they have order, with minimal faults in the future.

7.4.2 Less rigid systems for monitoring and control

Clients in the petroleum industry seem to have implemented rigid systems in their project organization(s). The general impression is that operators with long experience have established advanced engineering and control systems in order to monitor projects and operations. Statoil has especially been mentioned in relation to this understanding. Various IT-based systems prompt contractors to provide specific input data on several aspects of the project, such as progression, HSE, changes etc. These monitoring systems will together with project meetings, enhance control and quality. By contrast, it is described that numerous clients in the construction industry do not seem to have the same extensive systems and routines as for the petroleum industry. This can naturally be seen in relation to the fact that many clients only execute projects as a onetime event (client group 1). However, it seems to vary a lot within the construction industry, since there exist various client groups. Further to this, some mentioned that public property developers have more rigid systems for monitoring and control, and usually provide the project with clear and consistent control requirements and guidelines. This understanding seems to coincide with the fact that developers can have a portfolio of projects, and as they have the strongest focus on quality among all the three client groups. However, in projects where no such systems are available, status meetings seem to be the dominating methods of reporting.

7.4.3 MOM documentation versus LCI requirements

Tight control is required if the quality standard ordered is high, since it is easier to deviate from higher quality requirements than from lower quality requirements. Several interviewees underlined that operators, such as Statoil and ConocoPhillips among others, have an even stronger view on quality and HSE than the government and regulations. They provide projects with even more extensive project requirements and framework than provided in regulatory requirements.

Furthermore, work packages (ref. chapter 2.4.1) seem to come with signing protocols in the petroleum industry, which means that clients require reviewing work packages on an equal basis as for engineering and design drawings as mentioned above.

"*Work packages with signing protocols, it can also be used as a quality assurance tool. Document control can also be used as a tool on an equal basis"*

Interview object G (C, P)

However, it has been mentioned that this can vary from project to project, even though the majority of clients seem to require verification of work packages. These are in many cases also used for the purpose of status reporting, in which completion of work packages are registered to the progression. Further to this, interviewees mentioned that LCI requirements (ref. chapter **Error! Reference source not found.**) are common among projects in the petroleum industry and that each client usually provides projects with own LCI-requirements. LCI requirements require that engineering and design drawings (all technical documents) must be verified and signed before the construction work can start. First internally, then issued for acceptance externally to clients. The client will then have the opportunity to verify the design and add comments to the engineering work before the actual work starts. Hence, it is a quality assurance routine that enables the client to identify deviations from original requirements and preliminary design. It is hard to tell whether these routines are being followed step by step. However, it does highlight the fact that there exist strict control routines for documentation and engineering. Strict LCI requirements will further lead to a stronger focus on quality and thus enables the client to monitor and control the engineering and design work of contractors.

An important part of the LCI requirements is the section that describes As-built documentation – that is, the final documentation of the project must be in accordance to the real work performed. Hence, changes to the initial drawings must be revised to reflect the actual work, as minor changes during constructing and installing may occur. Initial drawings that have been accepted by the client must once again be revised and re-issued for acceptance. As-built documents will then be used to verify actual work under commissioning and testing**,** which is executed at the end of every project in the petroleum industry. This is to ensure that the deliverables is in accordance to regulation and contract, and that actual work is satisfactory. Clients apply quality assurance routines for planning, engineering and design, but also for actual constructing and installing work through strict LCI requirements and commissioning. This way, the client can actively control and verify that the services and deliverables provided by the contractor are in accordance to the quality standards as ordered from the beginning. These observations show that engineering, documenting, and commissioning and testing are important activities in projects in the petroleum industry.

By contrast, it is required in the construction industry that MOM documentation is to be handed over to the client before any certification of completion can be issued (ref. chapter 3.6.3). However, there are no regulatory regulations or requirements towards quality assurance of the MOM documentation. Hence, it will be individually up to each client, whether or not to implement quality assurance routines to verify that documentations are in accordance to actual work and regulatory requirements. For the given reason, quality assurance of project documentation in the construction industry, seem to have gained too little attention. This will in turn also affect the quality in design and engineering work as a result of less control. Importantly, it will provide a less solid basis to reveal faults and omissions, which can lead to problems in the operation phase. This understanding is further strengthened by the fact that compulsory third party verification of technical engineering and design work is required for critical safety elements of buildings. In particular, this regulatory framework was implemented by the PBL in 2013 to meet these challenges (ref. chapter 3.6.2). This enhances higher quality in design and engineering work, and at the same time secure that as-built documentations of critical elements are reliable with minimal faults.

7.4.4 High quality, but no quality assurance

Clients in the construction seem to rely on regulatory framework as the general quality requirements for building projects in relation to technical and structural elements. Hence, regulatory framework in the construction industry form a strong basis for monitoring and control, as clients usually do not provide own quality assurance framework. They may demand higher quality standards for some visual elements and provides the architects with specific requirements, but complicated technical elements that require technical understanding is often neglected. Further to this, several interviewees mentioned that clients may want high quality standards, and that they find it important to get the quality they have paid for, but do not implement sufficient quality assurance systems and routines to follow-up on the actual quality delivered by the contractors.

Normally, as long as clients in the construction industry get the product they asked for, they are not further concerned with knowing to what degree the initial goal was reached"

Interview object C (C, P)

Although high quality can be requested and expected, clients in the construction industry seem not to see the importance of quality assurance. This understanding reflects the issues regarding MOM documentation, and why third party verification has been implemented by PBL. However, keep in mind that one of the contractor's main responsible area is to ensure that projects and solutions is in accordance to regulatory requirements and yielding standards. Furthermore, if the regulatory framework fails to capture faults in designs and solutions, and none additional quality assurance routines exist; faults will be left unnoticed through the project, leading to unfortunate results. However, it is likely that some contractors have their own quality assurance routines to capture faulty elements to enhance quality and reliability, but as mentioned earlier, it becomes a challenge for contractors to perform the desired level of monitoring and control if the client does not see the benefit of it. The responsibility is in conflict with the contractors' objective, and client must motivate a stronger quality assurance for projects to enhance higher quality and thus prevent faults in the execution of the projects. It is important to understand the fact that faults in the operation phase can become much more costly than to identify and correct faults during the execution of the project.

"It is always better to do it right the first time"

Interview object A (C)

7.4.5 Key findings

Client's competence and focus on cost, time, and quality, will strongly affect the degree of monitoring and control utilized in projects. Furthermore, clients in the petroleum industry allocate a considerably higher amount of resources into monitoring and control practices, because of their high quality focus and to meet strict regulatory requirements. They seem to understand the importance of strict control, and some implement even higher requirements than minimal regulatory requirements. In the construction industry, monitoring and control practices highly depend on the clients' competence, and the general practice is minimal compared to the petroleum industry. A majority of clients rely only on regulatory framework and standards, and clients whom order higher quality do not always require additional quality assurance to control the final quality. Contractors have to adjust to the level of control and routines accordingly to the client's needs and requirements, and are not financially motivated to perform more control than what the client is willing to pay. Less quality assurance and control will naturally form a basis for more errors and building faults.

7.5 How clients directly and indirectly influence changes

Changes are preferably desired early in a project, as the ability to influence cost is higher and the cost of change is lower (ref. chapter 2.6.2). Among other factors, whether a project becomes successful or not, often depends on the amount of changes that will occur throughout the project. That is, changes can be considered as a deviation to the original plan, all of which is a natural process of any project, since projects are dynamic and unique. However, it is necessary to recall that project changes always occur, but do not necessarily lead to change-orders. Whether a change leads to a change-order request or not, it must be viewed in relation to the contract at hand, as there exists various types of changes. This analysis only includes differentiates between client-initiated changes, and project changes initiated by the project

team, in which the last mentioned is further referred to as *errors and omissions* (ref. chapter 2.6.1).

7.5.1 Late changes and large overlaps in parallel design and building

A majority of interviewees from the construction industry mentioned that parallel design and building, along with late changes are common challenges in the construction industry, all of which may lead to cost overrun, and increase the potential for delays.

"The projects that are well planned and prepared, are arguably those that are most successful, and also the projects without many changes. Such projects have fewer incidents and building faults, and are often completed within time, which involve little change-related work".

Interview object C (P, C)

Figure 7-6 illustrates the general impression of where changes in most cases occur in a project in both industries, base on statements from the interviewees.

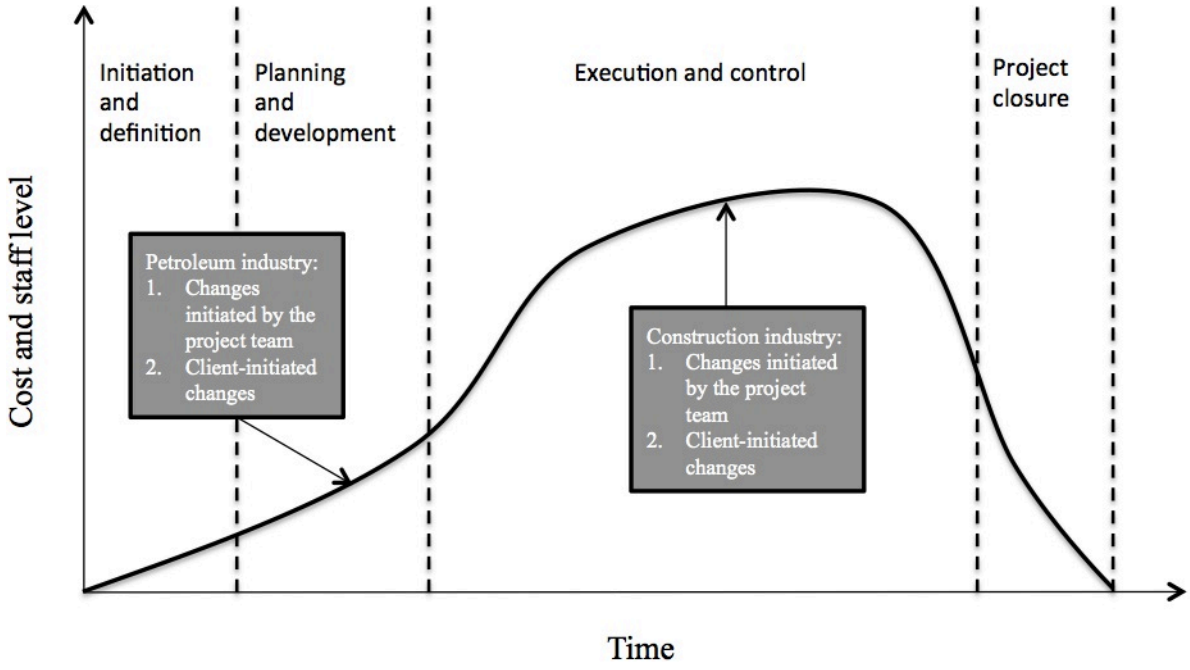

Figure 7-6: Where changes arise

The degree of planning and engineering in the petroleum industry is way more extensive compared to the construction industry. The various levels of planning and engineering play a major role in regards to why a majority of project changes in the petroleum industry usually occurs within the planning and development phase, and not in the execution phase (as for construction projects).

Parallel design (engineering) and building is a reality in both industries, but only mentioned as problem by interviewees from the construction industry, as it often leads to frequent re-building work (ref. chapter 7.3). It is a problem since construction projects often initiate and/or identify changes later than projects in the petroleum industry (i.e. errors and omissions and client-initiated changes). However, several interviewees further described that construction projects seem to perform surprisingly well, despite this challenge.

7.5.2 Errors and omissions as to poor planning, engineering and design

The accuracy and degree of details provided in the project specifications given by the client can in many ways be inadequate. It becomes difficult for contractors to perform detailed planning and engineering on the basis of uncertain and incomplete information, and thus both clients and contractors usually expect project changes. Further to this, the degree of planning usually reflects the level of complexity and uncertainty of a project. In the petroleum industry, critical changes caused by unforeseen conditions offshore, often lead to severe cost overruns and delays. Hence, EPC-contractors must ensure that planning and engineering is of high quality and reliability, as changes in the installation stage (offshore) can place a major threat on the project's final outcome. Therefore, if a change were to occur later in the construction stage or in the installation process, it becomes likely that all prior planning and engineering, to a certain degree, must be redone. The cost to redo engineering and detailed drawings can become extensive, not to mention the logistical and capacity (personnel and materialistic) challenges offshore that will add additional problems and costs to the project. Hence, a change in the installation stage is therefore costly and is no way desirable for offshore projects. As mentioned, both clients and contractors in the petroleum industry understand these conditions and therefore desire to reduce uncertainty and risk as much as possible early in the project. Understand that the construction process usually occurs onshore and the installation process is offshore, all of which changes the conditions of the project dramatically (both economically and logistically). Further to this, when the project team (project manager,

engineers, architects etc.) proceeds with project activities, and more detailed planning and engineering work are performed; risk and uncertainty are reduced, and potential errors and omissions to the initial contract are revealed. As a result, a majority of changes featuring errors and omission will thereby be initiated or revealed in the engineering stage.

On the other hand, as mentioned before, conditions onshore do not stress construction projects the same way, since access to additional equipment, tools and personnel are less complicated (logistics and capacity). Not to mention that the related costs are minimal compared to projects offshore. Hence, changes in building projects are often less complex, and the physical conditions onshore usually remains the same the entire building project, all of which gives construction projects more flexibility. Onshore conditions and the nature of the projects do not require clients and contractors in the construction industry to identify changes early as for an offshore project. That is, at least the mentality that several interviewees have described. Project manager and clients are rather committed to see results, as there is a strong focus on cost and time. Poor planning and design can be the result of a strong focus on cost and time (ref. chapter 7.2). Hence, as planning and detailed engineering and design are essential in the process of identifying errors and omissions, it becomes natural that changes are identified later in building projects. However, errors and omissions can often lead to significant change-order requests featuring changes in scope, design and functionality etc. which influences the final result of the project. A mentality as mentioned above, may lead to unfortunate results. Hence, the level of detailed planning, engineering and design, deeply affect where errors and omissions occur in projects.

7.5.3 Client-initiated changes – often a result of poor competence

One of the main objectives of this thesis is to derive at an understanding of how clients can influence the end-result of a project. Whether the client focuses on quality, cost and/or time will influence where errors and omissions occur, as described in chapter 7.5.1. However, client-initiated changes have a rather direct impact on the project schedule – that is, contractors are obliged to perform most client-initiated changes (depending on the contract), and if not handled correctly, often leads to unfavorable consequences. In addition to "errors and emission changes", the level of planning, engineering and design also affect client-initiated changes. That is, early outputs (drawings, calculations, 3D- models etc.) from the

engineering and design processes, can be utilized to enhance the ability of the project team to address and communicate missing and/or inadequate information in the project specification. This communication process enables the project team to ask the clients (and end users) questions regarding the project and thus receive answers. The information required by the project team, may concern anything from design and functionality, as to the physical conditions of the project. By doing so, the project manager and team reduce risk and uncertainty, but at the same time determine what the client wants versus needs. The project team implicitly motivates thinking and opinions surrounding the project, and client-initiated changes become easier to identify. Therefore, a higher level of planning and engineering in the petroleum industry also enhance changes in the engineering phase. In this context, it becomes more challenging for construction projects to determine what the client wants versus need with less planning and design basis.

Further to this, several interviewees from the construction industry mentioned that client-initiated changes in building projects often concern visual elements. By contrast, client-initiated changes in the petroleum industry usually concern functionality, rather than only visual elements. In particular, projects in the petroleum industry are usually specialized, and functionality and reliability are often seen in relation with complex engineering and design, making changes in the planning and engineering stage more profitable for both contractors and clients. Clients in the petroleum industry seem to have the understanding that changes considering functionality and reliability of deliverables should be identified early, as it will enhance the overall quality of the project. Hence, clients with solid project understanding, often highlights changes in the planning and development phase, during detailed engineering and/or design (as early as possible) of projects. However, it is wrong to say that changes regarding visual elements are not as extensive as changes regarding functionality and reliability, since it can become extensive as well. Especially when they come in large numbers, and thus require planning and a lot of re-building work. In fact, it was mentioned that these types of change often occur too late in building projects – namely, in the building phase. Several interviewees also stated that client-initiated changes are more frequent in building projects with property developers. In particular in projects that involves a vast number of end user (large apartments and offices, and shopping mall etc.). In these projects the client usually include end user too late into the project, in which is a challenge for both the

project and the contractor, since it often leads to numerous change-orders late in the building process.

"Some clients are good at setting frames for changes initiated by end users, while some other clients introduce new user groups and opinions far into the production phase, leading to late change-order requests and more re-building work".

Interview object K (C)

However, property developers initiate these projects for sale or rental purposes, but the buyers are usually introduced when the project is in the building process, which in turn will lead to late change-orders. Furthermore, interviewees also mentioned that structural changes often occur under the same circumstances, but on a less frequent basis. However, a major contrast is that a change concerning visual elements are rather minor, but a change concerning structural elements become a challenge in the building stage, making it a difficult task for the project to perform the change-request. Structural changes require calculations and engineering and may influence the overall structure of the building. Hence, extensive structural changes require additional engineering and design. Interviewees mentioned that an approach to address this challenge is to perform less planning and design, and rather wait and expect that changes may occur. Interviewees also mentioned that it becomes crucial that the project manager provide a deadline to freeze the design in order for the project to proceed without any further delays and consequences. It is important to keep in mind that less planning can have unfortunate impact on the project, as it will delay uncertainty and risk to the building process and thus influence the overall quality of the project.

Further to this, several interviewees from the construction industry also mentioned that clients often do not demand and/or initiate changes before the construction projects start to materialize – that is, client-initiated changes often occur simultaneously as the client visually realize the progress and not earlier. This statement strengthens the understanding that numerous clients in the construction industry tend to have insufficient project understanding, and do not realize the perception of the "ability to influence cost". Clients and end user(s) in the petroleum industry generally have a higher competence compared to the majority of clients in the construction industry (ref. chapter 3.7.1). The general impression is that one-time clients in the construction industry tend to have lower competency, all of which can

become a challenge for projects, because of unrealistic expectations (time, cost and quality) and the fact that they often initiate changes too late.

"Often, the client doesn't have a professional understanding of projects, and doesn't see the consequences of late changes – a good example is the building of Norges Bank".

Interview object A (C)

Clients with project managing skills often recognize that the ability to influence cost is higher and the cost of change is lower early in a project and therefore, they understand that changes must be initiated as early as possible. Further to this, these findings emphasize the understanding that client's (and end user) competence is a major factor that influences where changes may occur in building projects, since they do not understand how changes can influence projects**.**

7.5.4 Late changes are still manageable

The building process in the construction industry is in many ways comparable to the construction and installation processes altogether, as illustrated in Figure 7-7. This is an important observation in regards to why it is acceptable and manageable for changes to occur in the building process of construction projects, but not for offshore projects. Changes early in the building process of a building project can have the same "*cost of change*" and "*ability to influence cost*" as in the engineering process of an offshore project. As mentioned earlier, onshore conditions give construction projects higher flexibility and is not limited to logistical and capacities issues as in offshore. Therefore, changes in the building phase of construction projects are still acceptable and manageable as a result of the project characteristics and physical conditions onshore, which is visualized in Figure 7-7. However, it is important to keep in mind that every project is unique and has different project duration (schedule). The only purpose of the figure is to illustrate the complex understanding as pointed out above, and does not yield as a general description for all type of projects.

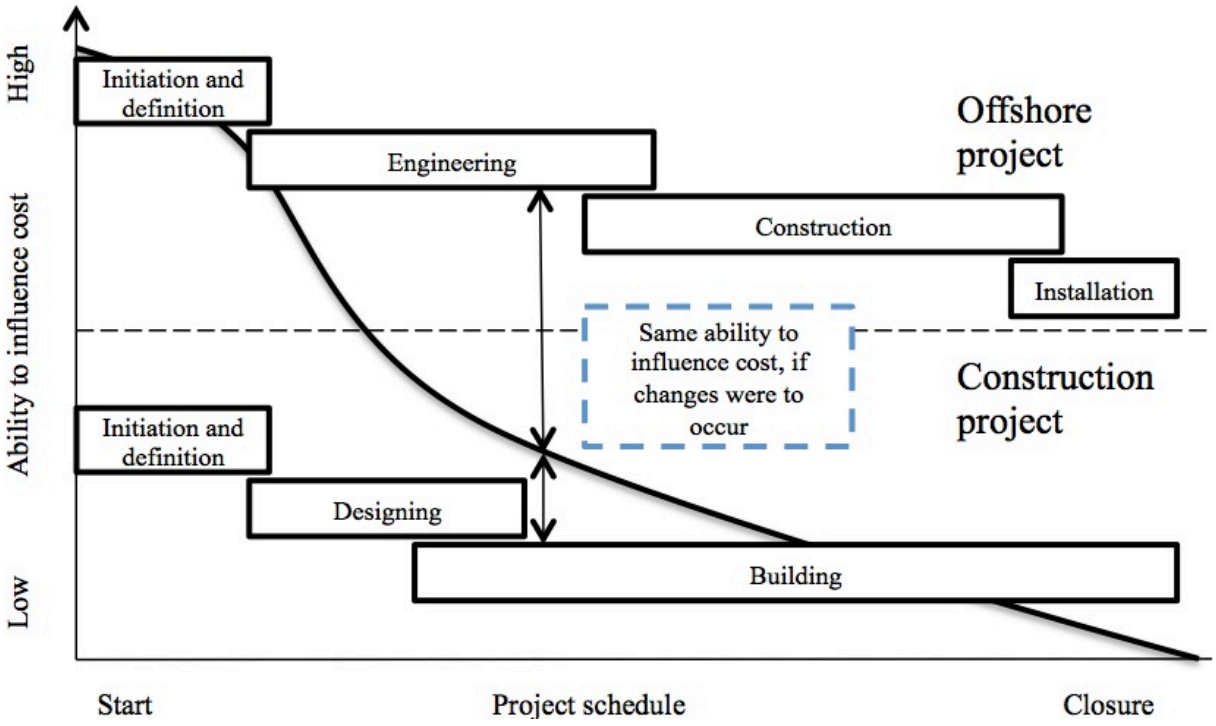

Figure 7-7: The ability to influence cost in relation to changes

Further to this, time-pressure often leads to parallel design and building in both industries, creating overlaps between *planning and development phase* and the *execution and control phase*. However, only interviewees from the construction industry mentioned this to be a major problem, which can be explained as the following:

- In the petroleum industry, more detailed planning and engineering is motivated by the client and the physical conditions offshore, which facilitate most errors and omissions to the engineering process. Time-pressure for projects in the petroleum industry do not lead to changes late in the installation process, as a result of extensive detailed planning and engineering practices. The fact that changes occur in the planning and development phase does not stress the project the same way although parallel engineering and building is a reality. However, if changes were to occur late in the construction process and/or installation process (offshore), the consequences are often much more severe compared to projects onshore.

- In the construction industry, a lower level of planning and design is possible because of the physical conditions onshore. However, this practice facilitates most errors and omission to the building process. Time-pressure leads to parallel planning, and since

there is in general to little focus on detailed planning, engineering and design, will increase the probability of changes in the building process. This will lead to additional re-building work and extra cost. The flexibility onshore gives building projects the same ability to influence cost as in the engineering process of an offshore project. For that reason, changes in the building process are still manageable although it will lead to additional re-building work.

7.5.5 Key findings

Client in the constructing industry influences where and how changes occur in a project. First, the client indirectly influences changes through the level of planning, engineering and design that is utilized in projects, which increases the potential for errors and omissions. Secondly, client-initiated changes will directly influence the project, as contractors are more or less obliged to perform changes on behalf of the client. A strong focus on cost and time in the construction industry leads to a greater overlap in parallel design and building. A combination with less detailed planning, engineering and design facilitates changes to the building process of the project. This can weaken the quality and end-result of the buildings/facilities. Late client-initiated changes can often be related back to the client's competence (ability to influence cost, and cost of change), and such changes are more frequent in building projects with numerous unknown end users. Less complex conditions onshore, provides more flexibility in the execution phase of building projects, and therefore changes are still manageable in the construction industry.

8 Discussion

8.1 Recommendations for improvement

8.1.1 The key role of the Norwegian Government

This research clearly illustrates the influence that clients in the construction industry have on several aspects of building projects. Furthermore, it has provided the understanding that clients in the construction industry usually do not motivate contractors to perform more detailed planning and design, or to execute projects with stricter control than to meet minimum regulatory regulations. The reason for this, among others, is highly correlated to the client's competence. As a result, it may lower the quality of the deliverables and reduce the profitability of the project. Projects in the petroleum industry on the other hand, usually have higher budgets and more allocated time. This reflects how clients motivate contractors to perform detailed planning and engineering, as well as extensive control. It is likely that the physical conditions and strict regulatory framework within the industry have also been a contributing factor for these practices. Regardless of the reasons, some operators in the petroleum industry (i.e. Statoil and ConocoPhillips) seem to be more advanced than the government in terms of providing projects and operations with stricter framework and requirements (ref. chapter 7.4.3). This illustrates that operators have a long-term quality focus, and thus they push contractors in the same direction. In the case of Statoil, the exceptional focus on quality can most likely be explained by the fact that the company is partly owned by the Norwegian Government. Nevertheless, Statoil has a significant dominance in the industry (ref. chapter 4.1) and their framework and requirements have a strong influence on the industry and its participants. This thesis has been unable to identify such a driver in the construction industry, because of the vast variation among clients, and the fact that no clients have the same market dominance as the Statoil has for the petroleum industry. With this understanding, this thesis underlines that the Norwegian Government has to take more responsibility for the improvement of the construction industry.

8.1.2 A lift in competence through compulsory arrangements

The R&D project *Byggekostnadsprogrammet in* 2005, was performed together with the objective of lifting the general competence in the industry, and various researchers have in relation to this project given specific recommendations in order to meet the objective. A report made by Multiconsult (2008), illustrates how compulsory arrangements in Denmark have led to higher project quality and also reduced the amount of severe building errors. The report concludes that voluntary arrangements are insufficient to improve the general quality in the industry. The implementation of the regulatory requirement for MOM documentation in 2010, and compulsory third party control in 2013 are efforts undertaken by the Norwegian Government after *byggekostnadsprogammet* (ref. chapter 3.7). These measures illustrate the fact that the government has taken more responsibility in the development of the industry, but it is still early to see the results of these measures.

This thesis has illustrated how the construction industry is still far away from being as regulated as the petroleum industry. This thesis shares the opinion that compulsory arrangements and requirements are necessary for quality enhancement of the industry. However, it would be inappropriate to implement the same extensive regulatory framework present in the petroleum industry, since the conditions onshore and offshore are different. This thesis cannot conclude on whether or not the measures already undertaken by the Norwegian Government are sufficient or if a more extensive approach will be necessary.

Lacking quality in many cases can be a result of poor competence among clients, and a lift in the competence among clients in the construction industry is necessary to improve quality and to give more profitable projects. Further to this, *Økt kundekompetanse* is another project that was executed in relation to the R&D project in 2005. The objective of this project was to increase the competence among first time clients (buyers) in relation to building, purchase, rehabilitation, and operation of houses. The project utilized an online information database to provide the client with knowledge in order to improve their skill set prior to the initiation of the project (Byggekostnadsprogrammet, 2009). The project was launched in 2007, and the end report made in 2009, showed that the online database had received over 42000 views within these two years. The report concluded that it is difficult to measure the overall effect, but it seemed like there has been a slight change in the behavior among first time clients since the release. Voluntary arrangements and free information databases are only beneficial if the

clients see the importance and usefulness of acquiring more knowledge. It is likely that some will benefit from such a tool, but it is not sufficient to reach out to all clients present in the industry. As for quality enhancement, this thesis also argues that compulsory arrangements are necessary to raise the general level of competence among clients, and that the Norwegian Government needs to focus on such measures in the future.

8.2 Validity and reliability

8.2.1 Research method

The empirical data in chapter 6 is presented as objectively as possible, unbiased by personal opinions and interpretation. The interviews have generated a lot of information, and it becomes impractical to include all information and statements that were given through the interviews. Only the information with high relevance for this research has been included. The data was first collected, categorized, and then irrelevant information was disregarded in order to derive at the empirical data as given. The process of selecting and categorizing information has most likely exposed the data to a certain degree of subjectivity. Citations have not been modified and reflect the real statements of interviewees, and all interviews have been audio recorded to enhance reliability.

As to the time constraints at hand, it has been challenging to capture all the literatures with relevance information for the topic. It was in addition, a challenge to set realistic milestones to when relevant knowledge must be acquired in order to fully exploit the interviews. The learning process has been gradual, as each interview has continuously provided this research with additional information of relevance to the topic. Furthermore, the flexibility of the qualitative method has made it possible to make certain adaptions and changes to the interview guide, and thus ensured that only new and relevant information was collected. Extensive literature research on the topic has also been made in order to validate new information and findings, which has strengthened the overall systematic involvement and thus enhanced higher validity. Personal experiences and earlier observations from both the industries have provided this research with a solid basis to be critical in the interviewing

process. It has also been highly relevant in order to validate the findings and has motivated several new opinions around the topic, leading up to the understanding as presented today.

8.2.2 The influence of contracts

In every project, the contract reflects the amount of management responsibility and risk a client is willing to take, and how much of it is to be transferred to the contractors (Lædre, 2009). Furthermore, the type of contract the clients select will truly influence the contractors. The comparison between the two industries does not provide any deeper understandings of the contractual arrangements in the industries. It does not provide a basis to conclude on what type of contract the clients are likely to select in regards to their competence level and/or focus, nor on how contracts will influence the project and contractors. The study of contracts is complex and requires a specific project data, and it deviates from the main objective of this thesis, as it demands a lot of effort and time. However, literature studies indicate that the findings and understandings of this research are of high relevance and validity, and that it forms a sound basis to provide the construction industry with recommendations of improvement.

8.2.3 Triangulation and other research

The analysis (chapter 7) in its content presents the findings of this study and illustrates the simplifications and interpretations that have been made during the analysis process in order to derive at the presented understandings. Despite the time constraint and limited data, this thesis has derived at several solid findings and understandings, which highly correspond to other literature studies of the Norwegian construction industry (ref. chapter 3.7). The triangulation with other research will enhance both reliability and validity of the findings and understandings, and thus improve the general quality of this study (ref. chapter 5.5). The fact, that several renowned researchers have derived at similar understanding as this thesis strengthens the quality of this study.

However, as there exist several similarities to other research, differences also exist on equal basis, but do not lower the validity of this study. To the contrary, they can actually provide the study with additional knowledge regarding the subject at hand. The research made by Latham (1994), among many other findings, illustrates that changes in projects, in the UK often occur

in the engineering and design phase. Although this research was performed in relation to the construction industry in the UK, it is likely that these findings are applicable to the Norwegian construction industry as well. This thesis has derived at the understanding that changes in building projects in the Norwegian construction industry often occur in the building phase, which differentiates strongly from Latham's (1994) understanding. It becomes challenging to reflect upon every potential element leading to various understandings, and only further research can be made on the variation to enlighten the contrast. However, possible key factors leading to this differentiation can be the amount of data collected for this study, or it can be a result of insufficient quality in the information provided by the interviewees. Further to this, all interviewees from the construction industry are in project managing positions. However, the project responsibilities in many building projects are divided among several managers from various companies (ref. chapter 3.3). In some projects, the engineering and design activities can be separated from the building contract. In this context, if the interviewees have limited experience from the engineering and design phase, their opinions can mislead the understanding made on the basis of the interviews.

9 Conclusion

A comparison of the construction industry and the petroleum industry in Norway has led to the understanding that the construction industry faces several challenges today. This understanding is shared by several other literature studies, indicating that the construction industry is in need of improvement.

The building segment of the construction industry incorporates most of the issues presented in this thesis. The segment is composed of various client groups, in which low competence is a common challenge for the industry. This is especially a reality among one-time clients. Poor competence disables the client from understanding the relationship between cost, time and quality. This forms a basis for the client to provide unrealistic requirements and framework for building projects and contractors, leading up to persistent time-pressure. As a result, it requires contractors to perform extensive parallel design and building. Less detailed planning and engineering practices in the industry will together with a strong cost focus among clients lead to unnecessary changes and re-building expenses. Despite this understanding, late project changes are also highly correlated with the client's understanding of the cost of change and ability to influence cost.

Furthermore, many clients in the construction industry do not seem to understand the benefits of control and quality assurance, and they rely only on minimum regulatory requirements to ensure quality for projects. This has proven to be unfortunate, as building faults concerning critical elements can become costly in the operation phase. However, clients can enhance better quality assurance routines in the future and thus improve the quality in engineering and design work with better control. They can also motivate contractors to perform more detailed planning by allocating more time and resources to the planning and development phase. As a result, this thesis argues that improved technical understanding and project management knowledge among clients, will motivate more detailed planning, engineering and design, as well as tighter control practices. This practice will reduce late changes and will in turn result in improved quality and profitability.

Clients in the petroleum industry have a general high level of competence, and both clients and contractors in the industry seem to understand the benefits and value of detailed planning. They also understand that strict quality assurance and tight control are necessary to ensure that their own quality requirements are met, and that the projects fulfill regulatory requirements. Some clients provide even stricter requirements in order to enhance quality, and Statoil, with its significant market dominance, seem to push the industry in the same direction.

There are no similar drivers in the construction industry today, which is why the Norwegian Government must take the main responsibility in the future development of the industry. Certain measures have already been undertaken by the government in order to enhance better quality in building projects, but it is still early to tell the effects of the measures. Despite this fact, no compulsory requirements have been implemented to enhance higher competence among clients. One of the reports undertaken in relation to *Byggekostnadsprogrammet* also indicated that voluntary arrangements are insufficient to reach the objective at hand. This research share the same understanding, concludes that voluntary measures are not enough in order to reach out to all clients, and that the Norwegian Government must focus on compulsory arrangements, enabling the construction industry to lift the general competence level among clients.

This study does not form an adequate basis to provide the construction industry with specific recommendations for which mandatory arrangements to implement, as more detailed studies are required. The only conclusion is that measures must be directed towards regulatory regulations and requirements and that the Norwegian Government must lead the development of the construction industry.

10 Further studies

The empirical data for this research is based on ten interviews, and does only provide a limited insight into both industries. Only contractors and consultants have been interviewed in this research. For this reason, it would be of great relevance to interview various types of client from both industries in order to enhance a better understanding on how clients' competence and focus reflects their choice of contract. It will also be relevant to interview consultants from the construction industry with relevant engineering and design experience to capture the full picture of the planning and engineering practices in the industry. Furthermore, by collecting specific project data, it will allow researcher to acquire a better understandings of the impact the various contract types have on projects.

It would be of interest to follow up the results of the measures that have already been undertaken by the Norwegian Government in relation to quality enhancement. This should be done in order to see whether or not it would be beneficial to implement more extensive regulatory requirements to enhance the client's competence.

As to the limited amount of empirical data, the findings in this research cannot be seen as representative for the whole industry. A generalization will only be possible for studies that have greater and more representative amount of data. However, all interviewees were picked with care from each industry, in order to provide this thesis with valuable information. The findings presented in this thesis form a basis for future studies. However, only quantitative studies will be able to prove the theories and findings presented in this thesis.

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Appendix A : Abbreviations and definitions

As-built drawings	Final drawings of a project, updated in accordance to changes in specification and working drawings during the execution phase
Building projects	Projects involving residential buildings, institutional and commercial buildings
Byggherreforskriften	Regulation for the client's responsibilities in construction projects
Certificate of completion	Building certificate issued by the relevant municipality at project completion. A requirement in the PBL
Client group 1	Clients executing projects to facilitate themselves and serve their own needs (typical one-time clients)
Client group 2	Clients executing projects for sale or rental purposes (private property developers)
Client group 3	Clients executing projects on behalf of the government in order to serve the public needs, and are also responsible for MOM (public property developers)
Construction projects	Projects involving specialized industrial construction, infrastructure and heavy construction
Contractor	Petroleum industry: Provider of one of the following services to an operator or rig owner: Engineering (E), Procurement (P), Construction (C), and/or Hook-up (H) and Installation (I) Construction industry: Company responsible for the execution/production of the building
DGM	Design Group Manager
DNV GL	Third party classification company
EPCI	Engineering, Procurement, Construction and Installation
EPCH	Engineering, Procurement, Construction and Hook-up

FEED	Front End Engineering Design: Output of the initiation and definition phase of a project in the petroleum industry
HSE	Health, safety and environment
ISO standard	International Organization for Standardization
JPPS	Joint Project Planning Session
LCI	Life Cycle Information: Information requirements given by a company for engineering, operation, maintenance, modification, repair and decommissioning work.
MOM documents	Management, Operation and Maintenance documents: Complete technical documentation (drawings and descriptions) of the building's structure and quality
NCS	The Norwegian Continental Shelf
NPD	Norwegian Petroleum Directorate
NS	*Norsk Standard* (Norwegian Standard): All standards determined and published by *Standard Norge*
NORSOK	*Norsk Sokkels Konkurranseposisjon*: standards developed by the Norwegian petroleum industry
Operator	Petroleum company with license for exploration, development and production of oil and gas
PBL	*Plan- og bygningsloven* (Planning and Building Act): Legal framework for planning and building matters
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
Property developer	Private or public organization executing several building- or construction projects
Rig owner	Petroleum service company that provides services towards operators
R&D Project	Research & Development Project

SM	Site Manager
Supplier	Petroleum industry*:* Organization providing a product and/or parts, e.g. producer, distributor, retailer or vendor of a product. Construction industry*:* Organization delivering manufactured goods and parts to the construction site
WBS	Work Breakdown Structure

Appendix B : List of interviews

Date of interview	Interview object	Age	Type of company and position	Background/education	Experience from industry
31.03.14	A	30	Construction consulting firm, Project Manager	MSc. Civil Engineering and Organizational Theory	Construction (C)
01.04.14	B	43	Construction consulting firm, Project Manager	BSs. Construction Engineering	Construction (C)
01.04.14	C	55	Construction consulting firm, Senior Project Manager	BSc. Electrical Power Engineering	Construction (C), Petroleum (P)
08.04.14	D	31	Petroleum contractor, Project Coordinator	Upper Secondary School, Chemical Processing	Petroleum (P)
10.04.14	E	35	Petroleum contractor, Change & Risk Lead	MSc. Business & Administration	Petroleum (P)
11.04.14	F	47	Petroleum contractor, Project Manager	MSc. Electical Engineering	Petroleum (P)
15.04.14	G	37	Petroleum contractor, Department Manager HVAC	BSc. HVAC Engineering. Additional education: Project Management	Construction (C), Petroleum (P)
30.04.14	H	53	Construction contractor, Project Manager	MSc. Civil Engineering	Construction (C)
06.05.15	I		Petroleum contractor, Technical Project Manager	BSc. Electrical Engineering. Additional education: Economics & marketing and project managment, Risk Analysis & Risk Management	Petroleum (P)
07.05.15	J	57	Construction contractor, Project Manager	BSc. Construction Engineering	Construction (C), Petroleum (P)
	K	53	Construction contractor, Project Manager	BSc. Construction Engineering	Construction (C), Petroleum (P)

Appendix C : Interview guide part 1

Introduction

The objective of this interview is to address the differences in project management between the petroleum and the construction industry, and also to see what influence clients have on projects.

All questions must be answered from the perspective of your industry – namely, either the petroleum or the construction industry, unless stated otherwise. It must also be answered on the basis of your personal experience.

Personal information

(Please fill out the information listed below)

Name:

Age:

Current company and position:

Background/education:

Working experience:

Questions:

1. How are projects normally planned and to what detail?

2. How are projects normally monitored and controlled by the client, and how do contractors ensure project control?

3. What types of changes are the most common? How and where do they normally arise?

4. What is normally the client's focus and priorities (cost, time, quality)?

5. Do clients/end-users normally have high technical understanding and project management knowledge? How do you think the client's competence affect the project?

Appendix D : Interview guide part 2

1. How are projects normally planned and to what detail?
- What methods/tools are being used?
- How is the level of planning affected by the risk/complexity/physical project conditions?
- How good is the project basis?

2. How are projects normally monitored and controlled by the client, and how do contractors ensure project control?
- What routines/methods/systems are being used?
- How well is the quality assurance, and who sets the requirements?
- What documentation does the client require?
- How is the level of control affected by the risk/complexity/physical project conditions?
- Is it normal to perform testing/inspections with the client?
- Are there any third party controls?

3. What types of changes are the most common, and how do they arise?
- How are changes normally being handled?
- Does the baseline get updated in accordance to scope changes or deviations?
- What are the most challenging types of changes?

4. What is normally the client's focus and priorities (cost, time, quality)?
- Are there differences within the industry?

5. Do clients/end-users normally have high technical understanding and project management knowledge? How do you think the client's competence affect the project?
- Do client always know their needs?
- When and what types of changes are normally initiated by the client?

Additional question to interviewees with experience from both industries
What do you think are the major differences between projects and project management in the construction industry compared to the petroleum industry?
- Client types
- Complexity/risk?
- Planning, control and changes
- Documentation
- Regulatory requirements

Appendix E : Contract types (*entrepriseformer*)

Divided contracts:

In a divided contract, the client is responsible for the design and management of the project, collection of tenders, coordination of the building activities as well as monitor project progression. The client hires responsible designers and consultants in the design process, and contractor(s) to carry out the construction work when the design is completed. Organizationally, this means that all contractors reports to a site manager representing the client. This site manager is thereby responsible for the development of time- and costs, as well as the coordination of the various contractors. Further to this, he is also responsible for the design work and the coordination between the design- and building processes. In short, the client is responsible for all the tasks not covered in the divided contract towards the contractors (Meland et al., 2009).

Design and construct (DC) contracts:

In a design and construct contract, a main contractor is solely responsible for delivering the complete building in accordance with the given specification, time and cost. DC-contract is in many ways similar to a "Turnkey project" (Lædre, 2006). Furthermore**, t**he client only has one contract, which is with the DC contractor. The DC contractor is responsible for both the design and the building phase, which involves contracting, monitoring and control of all subcontractors and suppliers. Under the assumption that all contractual requirements have been fulfilled, all project risk is now transferred to the DC contractor, unless there is errors and omission in the predefined specifications in contract.

There exist several variants of a DC contract, but DC contractor is normally taken into the project at an earlier stage compared to other contract forms. In an early DC contract, the DC contractor provides most of the design and in a late DC contract, the contractor provides less design work. It is common to transfer architects and other consultants from the early design phase over to the DC contractor, and is often specified in the tender documents (Meland, 2000).

General construction contract:

In a general contract, the client has separated contracts with the various parties: the consultants and designers, as well as an individual contract with a main contractor that is responsible for the sub-contractors. Further to this, the main contractor is responsible for all the disciplines required in the project, and execute the work that has to be done, as well as taking on the additional risk (Undervisningsbygg, 2007).

Principal contract:

With this type of contract, the client has separate contracts with the consultants and designers, and another contract with the principal contractor, in which the last mentioned is responsible for a defined number of disciplines, and the remaining (separated) contracts between the client and the remaining contractors (Undervisningsbygg, 2007).

Construction Management contract (consultant agreement):

In many cases, the client does not have the right competence to execute a construction project alone and to constitute a project board. In a Construction Management contract, the client appoints separate contracts with different contractors, and hires (contracts) an external consultant as a *construction manager (CM)* with the responsibility of managing the whole project on behalf of the client. The CM contracts a designer along with other contractors, and is involved in issuing instructions, preparation of certificates and administration of all contracts related to the project. In the execution phase, the CM controls the progression of all contractors and contracts. Furthermore, the client is responsible for time, cost and quality, and the CM is contractually responsible for errors and damage in result of own negligence while executing the project. The main difference between a construction management contract and divided contracts is the extra link between the client and the contractors – that is, in a DC contract all contractors report directly to the client (Lædre 2006).