Master Thesis in Economics and Business Administration

Critical Success Factors that contribute to project success

By:

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The master thesis is carried out as a part of the education at Agder University and is therefore approved as such. However, this does not imply that the University answers for the methods that are used or the conclusions that are drawn.

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ACKNOWLEDGEMENT

The completion of this master thesis is the end of my master program at Agder University. I am pleased to have finished the five year program, but at the same time sad that my time as a student is over, at least for now. It has been five great years of my life and when I am turning in this thesis, I see that one chapter in my life is over while a new chapter is about to start.

This master thesis was a challenge; it started with big enthusiasm, went over in frustration and ended up with a job that had to be finished before deadline.
As I went through the different phases I received valuable assistance and guidance from a number of people.

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Stavanger 15 th May 2009

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ABSTRACT

This master thesis explores critical success factors that contribute to project success. *A pathway to success* is presented with nine success factors that are critical in order to achieve project success for oil and gas projects. The critical success factors that are presented are 1) Reservoir complexity, 2) Appraisal strategy, 3) Reservoir front-end loading, 4) Scope and technology, 5) Team integration, 6) Facility front-end loading, 7) Well front-end loading, 8) Target setting and 9) Project execution discipline. I have chosen to have my main focus on two of these success drivers; target setting and project execution discipline. The reason for this is that I wanted to have my main focus on Project Management.

The study attempts to determine if target setting and/or execution discipline contribute to project success. In order to identify this relationship a qualitative and quantitative research was conducted. Ten hypotheses based on theory and IPA's previous findings were formulated. The hypotheses state the relationship between cost and schedule (dependent variables) and the following independent variables: target setting, project control, team development, project manager turnover and major late changes.

To test the hypotheses and explore the relationship between the independent and the dependent variables a regression and a correlation analysis were conducted. The results and main findings are presented below.

The statistical results proved that:

- A cost overrun could have been avoided by setting conservative targets
- A cost overrun could have been avoided by having good project control

I found relationships between the following factors:

- Cost overrun could have been avoided by good team development
- Schedule overrun could have been avoided by good team development
- Target setting has no influence on production attainment

However, the sample size was too small in order to be confident that these results were not caused by random factors. More projects have to be included in the analysis and further research has to be done.

I found relationships between the following factors:

- Schedule overrun could have been avoided by setting conservative targets
- Schedule overrun could have been avoided by having good project control.

However, the significance level was not high enough to be confident that these findings are not caused by random factors.

I did not get reliable results from the analysis of the independent variables; project manager turnover and major late changes. The reason for this is that only 3 of 17 projects in my sample did not experience turnovers and only 2 of 17 projects did not have major late changes. This affect the results and more projects have to be included and further research has to be done in these areas to avoid results caused by random factors.

The results from the analysis indicate that:

- Project Manager Turnover do not increase schedule slips
- Project Manager Turnover increase cost overrun
- Major Late Changes do not increase schedule slips
- Major Late Changes do not increase cost overrun

The reason that my results showed that major late changes did not increase schedule slips was due to the projects that did not experience major late changes. One of these projects had a schedule slip, while the other project did not have a schedule slip. This affected the results and these findings are caused by random factors. There are also reason to believe that major late changes effect on cost overrun were due to random factors.

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KEYWORDS AND DEFINITIONS

Term	Definition / explanation
Asset owner	Owner of a business case. Normally a unit within a business area
Asset owner's representative	Person appointed by the asset owner to follow up the investment project, on behalf of the owner. Normally a person from the same business area as the asset owner.
Benchmarking	Comparison of selected indicators for a project against corresponding indicators for compatible facilities, normalised for relevant parameters e.g. resource basis, capacities, product(s) etc.
Best Practice	The total requirements and guiding documents (e.g. guidelines, checklists, templates and tools) on how to perform tasks within the various work processes.
Capital Value Process (CVP)	Statoilhydro's decision process for investment projects.
Concept phase	The concept phase shall provide a firm definition of the design basis and select the preferred commercial and technical concept.
Critical success factors	The set of circumstances, facts, or influences which contribute to the project outcomes.
Decision Gate (DG)	A predefined point in the project model where StatoilHydro has to make appropriate decisions whether to move to the next phase, make a temporary hold or terminate the project.
Decision Gate Support Package (DGSP)	The total package of documentation that forms the basis for the decision.
Definition phase	The definition phase shall develop and document the business concept to a level ready for sanction.
Efficiency	Productivity improvement
Effectiveness	Quality improvement
Facilities	The total system from well-head to refined product, including the following competence areas: subsea, pipelines, transport, process upstream and downstream, refining, platform and materials technology.
Feasibility phase	The feasibility phase shall establish and document whether the development of a business opportunity is technical-, operational-, and organisational feasible, and that both economical analysis and relevant stakeholder analysis justify further development.
Front End Loading (FEL)	A measure of the level of definition of a project; FEL provides a picture of the project readiness for execution and level of risk.
HAZOP analysis	A systematic review of a process or plant to identify possible safety or operational deviations from normal process conditions and to evaluate their consequences, causes and possible corrective actions.
Milestone	A significant event in the project, usually completion of a major deliverable.
Project	A unique process, consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including constraints of time, cost and resources.
Project Execution phase	The execution phase shall complete the project scope up until DG 4, including detailed engineering, procurement, construction, installation and completion activities.

Project Management	Planning, Organizing, monitoring, controlling, reporting all aspects of a project, and the motivation of all those involved in it to achieve the project objectives.
Project Manager	The person responsible for management of a project, defined by a project assignment
Project Success Criteria	The set of principles or standards that measures a project success.
Value Improving Practice (VIP)	A creative and organized method for optimizing the cost and performance of facilities by focusing on simplifying development, facilities, processing or equipment while satisfying needed functionality.
Gap	The difference between planned estimates and actual outcome.

ABBREVIATIONS

Abbreviation	Explanation
AOR	Asset Owner’s Representative
BA	Business Area
CII	Construction Industry Institute
CSF	Critical Success Factor
CVP	Capital Value Process
DG	Decision Gate
DGSP	Decision Gate Support Package
FEL	Front-End Loading
HAZOP	Hazard and Operability (Study)
HSE	Health, Safety and Environment
IPA	Independent Project Analysis
MLC	Major Late Changes
PCI	Project Control Index
PIR	Post Investment Review
PMT	Project Manager Turnover
PT	Project Team
R&D	Research & Development
TDI	Team Development Index
VIP	Value Improving Practices

PART I: INTRODUCTION

Chapter 1: Introducing the research question

1.1 Introduction

This thesis is divided into three main parts and six chapters. Part I consists of one chapter that explains the motivation for the assignment and introduces the research question.

Part II is divided into three chapters and intends to give you a theoretical framework of this study. The chapters are; 1) Literature review, 2) Operating model & work processes in StatoilHydro and 3) Research methods.

The literature review presents a definition of a project and project management before it introduces you to the project life cycle. Second this chapter presets a definition of a project success and clarifies the difference between success criteria and success factors. Third, the literature review presents the main findings from previous studies on critical success factors in projects. Finally different methods that can be used to improve project performance are introduced.

The next chapter presents the operating model and work processes in StatoilHydro and intends to give an overview on how StatoilHydro makes their decisions. The chapter starts with defining StatoilHydro's operating model and work processes with special focus on the capital value process and decision gates. Then, the different business areas and roles and responsibilities are presented.

The last chapter in part II introduce the research methodology that is used in this study. The reliability and validity of the results are discussed and some ethical concerns that are tied up to this study are presented.

Part III is divided into two chapters. The first chapter introduces the model; *a pathway to success* where nine critical success drivers are presented. In the second chapter ten hypotheses are developed and analyses are conducted in order to test these hypotheses. The results, limitations of the study, suggestions for future research and criticism are presented in the end of this chapter.

1.2 Motivation for this assignment

This master thesis is a part of the master program in business and administration at Agder University in Kristiansand. A master thesis is mandatory in the last spring semester of the five year long master program.

I chose to write about success factors in project management because I had subjects that introduced me to this area. I found success factors very interesting and wanted to learn more and get a deeper understanding of how these factors contribute to success.

It was very important for me that the study was realistic and gave me direct engagement in real life assignments. I also wanted to use this assignment as a basis for personal growth and advancement.

In the summer of 2008 I was introduced to StatoilHydro. I found the company very appealing and wanted to maintain the contact with StatoilHydro. Writing my master thesis in cooperation with StatoilHydro was a great opportunity to get to know the company from the inside and be introduced to their work methods.

1.3 Research question

The focus of this master thesis is to identify critical success factors and their relation to project success. My starting point was theory on critical success factors in projects and the model; *a pathway to success* which shows nine critical success factors in oil and gas projects.

My research question is:

Can target setting and/or execution discipline contribute to project success?

Several studies have been conducted in this area in order to find out which factors that drives project success. These studies will be presented in the literature review in the next section.

PART II: ESTABLISHING A THEORETICAL FRAMEWORK

Chapter 2: Literature review

2.1 Defining a Project & Project Management

We can ask ourselves; what is a project? There are several different answers and definitions that are presented in the literature. However there are still universal characteristics that describe a project. These includes: that a project has a defined beginning and an end, specific goals and they have a series of interrelated activities. Another universal characteristic is that projects have some kind of constraints, usually involving time, cost and resources.

StatoilHydro (2009) defines projects as:

> *A unique process, consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including constraints of time, cost and resources.*

Project management can be thought of as the skills, tools and management processes required to undertake a project successfully. This includes project management components such as:

- *A set of skills*; specialist knowledge, skills and experience are required to reduce the level of risk within a project and thereby enhance its likelihood of success.

- *A suite of tools;* Various types of tools are used by project managers to improve their chances of success. Examples can include document templates, registers, planning software and so on.

- *A series of processes;* Various processes and techniques are required to monitor and control time, cost, quality management, change management, risk management and issue management (Turner, 1999).

StatoilHydro defines project management as:

> *Planning, organizing, monitoring, controlling, reporting all aspects of a project, and the motivation of all those involved in it to achieve the project objectives (StatoilHydro, 2009).*

The project life cycle is a theoretical framework which helps the project manager to organize a project, based on the phases or stages that a project goes through. The different phases have different activity levels and the project manager can use the project life cycle as a tool for better understanding the likely requirements for the project (Pinto & Slevin, 1988). The different phases are shown in figure 1 and consist of:

Initiating is the first phase of a project. During this phase a project business problem or opportunity is identified and a project assignment is established. P*lanning* is the second phase of the project life cycle. Once the assignment of the project is established, the project scope, activities, plans and deliverables needs to be defined. The project also needs to mobilize a project team. The third phase is *Execution.* This phase involves implementing the plans created during the project planning phase. The last phase is *Closure* and involves formalizing an acceptance and releasing the final deliverables. The project is brought to an end. There are also a series of management processes that are undertaken to monitor and *Control* the deliverables of the project.

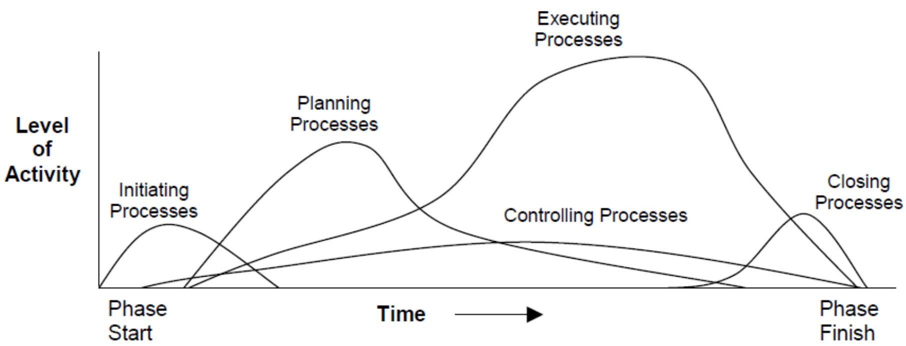

Figure 1 Project Life Cycle (PMI, 2003)

Figure 1 shows an example of a project life cycle. The level of activity is shown on the vertical axis and time is shown on the horizontal axis. The project starts with initiating processes, than goes on with planning processes, executing processes, and finishes with closing processes. There will also be controlling processes that run from the beginning to the end of the project. From the graph we can see that the different phases have different level of activity and different time consumption. The project starts with a small level of activity, than increases the activity when it goes over in the planning phase. The execution phase is the most time consuming and have the highest level of activity. When the project comes to an end the level of activity decreases and the project is closing up.

Project activities must be grouped into phases because by doing so, the project manager and the project team can efficiently plan and organize resources for each activity. An objective measurement of achievement can be done in order to justify their decision to move ahead, correct or terminate the project. It is important to organize project phases into industry specific project life cycles because each industry sector involves specific requirements, tasks and procedures that have the same processes as shown in figure 1.

2.2 What is success?

To determine what success is I first want to clarify the difference between two terminologies *project success criteria* and *critical success factors* (Lim & Mohamed, 1999):

Project success criteria are “the set of principles or standards by which project success can be judged”. *Critical success factors* are “the set of circumstances, facts, or influences which contribute to the project outcomes”.

Project success criteria can be perceived as a set of measurements that are used to decide if the project was a success or not. In other words we can say that project success criteria assess the project outcome. Critical success factors can be observed during the project and it is possible to influence these factors. If the success factors are well represented in the project there will be a bigger possibility of project success (Ø. Meland, 2008).

Some researchers observe critical success factors (CSFs) as independent variables and project success criteria as dependant variables (Zwikael & Globersen, 2006). The critical success factors can improve the project outcome, which in turn can be assessed by a set of measurements as indicated in the project success criteria. This relationship is shown in figure 2.

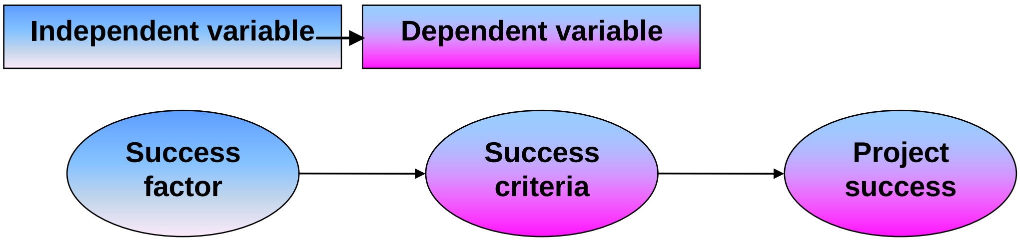

Figure 2 Success factor and success criteria adapted from (Ø. H. Meland, 2000).

2.2.1 Project success criteria

We have seen that measurement of a project success can be done by using project success criteria. The question is which success criteria should be used? And what is success? There is not one correct answer on these questions. Success will be situational and differentiate from project to project and from company to company. Project success should be viewed from the different perspectives of the individual owner, developer, contractor, user, the general public and so on (Lim & Mohamed, 1999). The different perspectives explain the reason why the same project could be perceived as a success by one group but a failure by another group, (ibid). For example, one project might be successful in the view of the client because the project delivered the expected quality, but considered unsuccessful in the aspect of project manager as the project was not finished within the expected timeframe. Historically, there has been an attempt to define project success in an objective way. Atkinson (1999) and others have used *The Iron Triangle* to measure success. This triangle includes; Time, Cost and Quality. If the project came in on time, on budget, and had the quality that was expected, it was considered a success (Pinto, 1988).

What if the project satisfied the three aspects of the iron triangle, but the project activity caused a fatal accident and two people lost their lives. Is this project a success? In the modern business this triangle comes to short. More recently, additional elements have been added to the formula of success. These parameters normally include; performance, safety and client[1] satisfaction (Pinto, 1988).

[1] By "client" I refer to any party for whom the project is intended, either internal or external to the organization

In the aspect of StatoilHydro the criteria for project success is that the project comes in on time and on budget. However this is a narrow perspective. A project that comes in on time and on budget might be seen as a success from the project department perspective, but can not be considered as a success for StatoilHydro. A wider perspective leads us to criteria such as operability and production attainment. In the end of the day it is production attainment that brings the cash flow to the company.

Production attainment is defined as:

> *The ratio between the actual production and the planned production for the second 6 months[2] of operation compared with the production profile planned at authorisation (IPA, 2007a).*

The following is been said about the correlation of production attainment and success;

> *Production attainment is the single greatest leveraging element of project success (IPA, 2009).*

Another perspective is the Health, Security and Environmental (HSE) aspect. This has high priority in StatoilHydro and is included in their strategy. StatoilHydro want to ensure safe operations that protect people, the environment, communities and assets. They believe that all accidents can be prevented (StatoilHydro, 2008c).

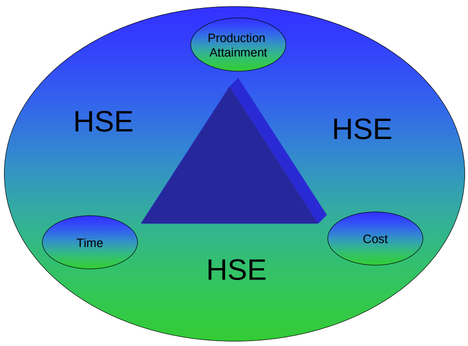

Figure 3 StatoilHydro's Project criteria

Figure 3 shows Statoil Hydro's success criteria with production attainment as the greatest element of project success. Time and cost are secondary criteria. The HSE aspect is the building block for everything StatoilHydro does.

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[2] To allow for a settling in period and adjusted to schedule slips

2.2.2 Critical success factors for projects

Despite the fact that the project outcome may be assessed subjectively, there are certain factors that have been demonstrated to be strongly associated with project success. There have been many studies on this area and I am going to present the main findings from the different studies.

Pinto and Slevin (1988) are the first that attempt to develop a collective set of Critical Success Factors (CSF) related to project implementation success. They studied a Project Implementation Profile model (PIP) in order to identify which aspects of a project determine its success. PIP provides a measurement instrument for project managers to assess those factors. The result of their study is a list of ten CSF's. These factors are; project mission, top management support, project schedule/plan, client consultation, personnel, technical tasks, client acceptance, monitoring and feedback, communication and troubleshooting.

Pinto and Prescott (1988) explore the importance of 10 CSFs over the life of a project and discover that the relative importance of several CSFs vary at different phases of the project life cycle. In the late study by Pinto and Prescott (1990), they categorize the ten factors listed above into strategic factors (planning process) or tactical factors (operational process).

Belassi and Tukel (1996) address project characteristics which are related to the project manager and team members, factors related to projects, organization and the external environment to classify the CSFs.

Cooke-Davies (2002) developed a set of questions to guide the grouping of critical factors such as;

- What factors are critical to project management success?
- What factors are critical to an individual project?
- What factors lead to consistently successful projects?

The result from his study was twelve critical factors that he divided into three groups. The three groups were critical factors to project management success, critical factors to an individual project, and critical factors leading to consistently successful projects. The twelve critical factors are listed in table 1.

Westerveld (2003) constructs the framework of critical success factors related to the organization including leadership and team, policy and strategy, stakeholder management, resources, contracting, and project management factors.

Fortune and White (2004) studied the human and organisational aspects of projects. The findings are that a project that includes more CSFs probably achieves a higher degree of success than the projects that include fewer CSFs.

Zwikael and Globerson (2006) found that the most critical planning processes, which have the greatest impact on project success, are activity definition, schedule development, organizational planning, staff acquisition, communication planning, and project plan development.

A summary of the above literature and the results of the studies on project CSFs are presented in table 1. This table includes the key findings of each study.

Pinto & Slevin (1987)	Belassi and Tukel (1996)	Cooke-Davies (2002)	Westerveld (2003)	Fortune & White (2004)	Zwikael & Globerson 2006
1. **Project Mission:** Clearly defined goals and directions. 2. **Top Management Support:** Willingness of top management to provide necessary resources and authority. 3. **Project schedule/Plan:** Detailed action plans 4. **Client Consultation:** Communication, consultation and achieve listening to all impacted parties 5. **Personnel:** Recruitment, selection and training 6. **Technical Tasks:** Availability of required technology, and expertise 7. **Client acceptance:** The act of "selling" the final projects 8. **Monitoring & Feedback:** Timely provision of comprehensive control information at each stage in the implementation process 9. **Communication:** Provision of appropriate communication networks and necessary data to all key actors 10. **Troubleshooting:** Ability to handle unexpected crises and deviation from plan	1. **Factors related to the project manager and project team members** *a.* *Manager*: ability to delegate authority, ability to trade-off, ability to coordinate, perception of his role, competence, commitment *b.* *Project team members*: technical background, communication skills, trouble shooting, commitment 2. **Factors related to projects:** size, value, uniqueness of project activities, density, life cycle and urgency 3. **Factor related to the organization:** top management support, organizational structure, functional managers' support 4. **Factors related to external environment:** political environment, economical environment, client, competitors, etc.	• **Critical factors to project management success** *Time performance measurement* 1. Adequate company-wide education on risk management concept 2. Assign risk ownership 3. Adequate visible risk register 4. Update risk management plan 5. Adequate documented project responsibilities 6. Keeping project as far below 3 years as possible *Cost performance measurement* 7. Allowing changes to scope only through a mature scope change process 8. Maintaining the performance measurement baseline • **Critical factors to an individual project success** 9. Existence of effective benefit delivery and management process • **Critical success factors leading to consistently successful projects** 10. Portfolio and programme management 11. Project, programme and portfolio performance and feedback system 12. Learning organization	1. **Leadership and team:** represents the way to manage the project, leadership style, and behaviour 2. **Policy and strategy:** represents the project goals and directions and combines the interests of stakeholders 3. **Stakeholder management:** represents the way to co-operate with various stakeholders 4. **Resources:** efficient and effective use of resources 5. **Contracting:** establishment of contractual relationships 6. **Project management:** Scheduling, Budget, Organization, Quality, Information, Risk	• Goals and Objectives • Performance monitoring • Decision maker • Transformations • Communication • Environment • Boundaries • Resources • Continuity	• Project Plan and development • Scope Planning • Scope definition • Activity definition • Activity sequencing • Activity duration estimate • Schedule development • Resource planning • Cost estimate • Cost budgeting • Quality planning • Organizational planning • Staff acquisition • Communication planning • Risk management planning • Procurement planning

Table 1 Critical success factors adapted from (Hoang & Lapumnuaypon, 2007)

2.3 Improving Project Performance

The collapse in oil prices together with a very high cost level from suppliers increases the need for managers to continuously improve efficiency and effectiveness. Managers need to know which performance measures are most critical in determining the firms overall success. Benchmarking is a tool to improve project performance by identifying successful companies and the underlying reason for their success.

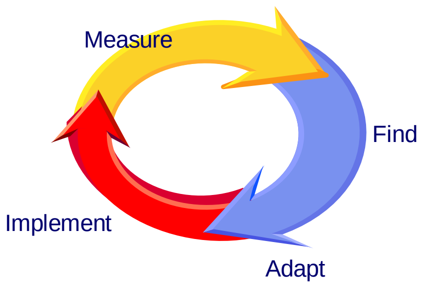
There are many definitions of benchmarking, one is (Østrem, 2008):

> *Measuring and comparing products, services, processes and functions to the best in class to identify, understand and implement better ways to run business as part of continuous improvement*.

Bjørn Andersen (2007) from NTNU defines benchmarking as:

> *The art of being humble enough to admit someone is better than yourself and at the same time be wise enough to learn.*

The essences of benchmarking can be explained by a benchmarking wheel as shown in figure 4. There are four phases of a benchmarking study.



The first phase is to *Measure* current business operations. The purpose of this phase is to determine the process to benchmark based on the organization's critical success factors, understand and document own processes and measure own performance.

Figure 4 Benchmarking wheel (Østrem, 2008)

The second phase is to *Find* the strongest competitor with the highest standards of excellence and compare the performance. The purpose of this phase is to identify relevant benchmarking partners and gain their acceptance for participation in the study.

The third phase is to *Adapt* the excellence from the best in class. The objective is to learn from competitors in order to improve own business operations.

The fourth phase is to *Implement* the improvements which is necessary to reach the highest standard of excellence – commonly called *Best Practices* (Bhutta & Huq, 1999).

Benchmarking is an important source of best in class processes and practices and help the organization to identify, understand and close business gaps. Benchmarking improve project performance because it increases cost and schedule awareness in projects. This awareness contributes to a better focus on the key success factors and enlarges the possibility of project success.

2.3.1 Measuring the Maturity of a Project

It is documented that greater pre-project planning efforts lead to improved performance on industrial projects in the areas of cost, schedule and operational characteristics (CII, 1996). The vice president of Burns & McDonald (2002) once said:

Fail to plan and plan to fail

There are few project managers that would disagree in this assertion. But how much planning is enough? A system developed by Construction Industry Institute (CII) measure the readiness of projects to move forward to and through the authorization process. This system is called the Project Definition Rating Index (PDRI).

Project Definition Rating Index (PDRI)

The PDRI is the first tool developed by CII to determine the degree of scope development of a project. It allows a project planning team to quantify, rate and assess the level of scope development on projects prior to authorization. The PDRI is a *best practice* tool that provides benefits for the company that uses it and for the project team.

The PDRI can benefit both owner and contractor companies. Owner companies can use it as an assessment tool for establishing a comfort level at which they are willing to authorize projects. Contractor can use it as a method of identifying poorly defined project scope definition elements. The PDRI provides a means for all project participants to communicate and reconcile differences using an objective tool as a common basis for project scope evaluation.

PDRI is a spreadsheet application to systematically measure the quality and completeness of the project scope. To calculate a project's PDRI score, project managers and team members use a checklist of 70 scope definition elements identified by research teams of project owners, contractors and engineer/constructors as critical to project success (Burns & McDonald, 2002). This checklist identifies and describes each critical element in a scope definition package and allows a project team to predict factors impacting project risk. It is intended to evaluate the completeness of scope definition at any point prior to the time a project is considered for authorization.

The PDRI consists of three main sections. These are basis of project decisions, front end definition and execution approach. Each of these main sections is broken into a series of categories which, in turn, are broken down into further elements. The complete list of sections, categories and elements are shown in table 2.

I. BASIS OF PROJECT DECISION	II. FRONT END DEFINITION	III. EXECUTION APPROACH
A. Manufacturing Objectives Criteria A1. Reliability Philosophy A2. Maintenance Philosophy A3. Operating Philosophy **B. Business Objectives** B1. Products B2. Market Strategy B3. Project Strategy B4. Affordability/ Feasibility B5. Capacities B6. Future Expansion Considerations B7. Expected Project Life Cycle B8. Social Issues **C. Basic Data Research & Development** C1. Technology C2. Processes **D. Project Scope** D1. Project Objective Statement D2. Project Design Criteria D4. Dismantling & Demolition Requirements D5. Lead/Discipline Scope of Work D6. Project Schedule **E. Value Engineering** E1. Process Simplification E2. Design & Material Alternatives Considered/Rejected E3. Design for Constructability Analysis	**F. Site Information** F1. Site Location F2. Surveys & Soils Tests F3. Environmental Assessment F4. Permit Requirements F5. Utility Sources with Supply Conds. F6. Fire Prot. & Safety Considerations **G. Process / Mechanical** G1. Process Flow Sheet G2. Heat & Material Balances G3. Piping & Instrmt. Diags. G4. Process Safety Mgmt. (PSM) G5. Utility Flow Diagrams G6. Specifications G7. Piping System Requirements G8. Plot Plan G9. Mechanical Equipment List G10. Line List G11. Tie-in List G12. Piping Speciality Items List G13. Instrument Index **H. Equipment Scope** H1. Equipment Status H2. Equipment Location Drawings H3. Equipment Utility Requirements **I. Civil, Structural, & Architectural** I1. Civil/ Structural Requirements I2. Architectural Requirements **J. Infrastructure** J1. Water Treatment Requirements J2. Loading / Unloading / Storage Facilities Requirements J3. Transportation Requirements **K. Instrument & Electrical** K1. Control Philosophy K2. Logic Diagrams K3. Electrical Area Classifications K4. Substation Requirements / Power Sources Identified K5. Electric Single Line Diagrams K6. Instrument & Electrical Specs.	**L. Procurement Strategy** L1. Identify Long Lead / Critical Equipment & Materials L2. Procurement Procedures & Plants L3. Procurement Resp. Matrix **M. Deliverables** M1. CADD / Model Requirements M2. Deliverables Defined M3. Distribution Matrix **N. Project Control** N1. Project Control Requirements N2. Project Accounting Requirements N3. Risk Analysis **P. Project Execution Plan** P1. Owner Approval Requirements P2. Engr. / Constr. Plan & Approach P3 Shut Down / Turn around Requirements P4. Pre-Commissioning Turnover Sequence Requirements P5. Start-up Requirements P6. Training Requirements

Table 2 PDRI sections, Categories & Elements adapted from (CII, 1996)

The grading of PDRI is performed by evaluating and determining the definition level of individual elements. The elements are rated numerically from 0 to 5. Elements that are as well defined as possible receive a perfect definition level of one. Elements that are completely undefined receive a definition level of five. All other elements receive two, three or four depending on their level of definition. If there are elements that are not applicable for the project, they receive a zero. In this way they will not affect the final score. The definition levels are defined in table 3.

Definition Levels: 0 = Not Applicable 1 = Complete Definition 2 = Minor Deficiencies 3 = Some Deficiencies 4 = Major Deficiencies 5 = Incomplete or Poor Definition

Some elements should be rated with a simple yes or no response indicating that they either exist or do not exist. It is only level 0, 1, or 5 that can be chosen for these elements. The PDRI Research team hypothesized that all elements were not equally important with respect to their potential impact on overall project success and that each needed to be weighted relative to one another.

Table 3 PDRI Definition Levels adapted from (CII, 1996)

Higher weights were to represent the most important elements. The weighing process is complex and beyond the scope of this thesis, but you can see the full weighting and the score sheet in Appendix A.

PDRI uses a 1000 point scale and after this process is repeated for each element shown in table 2 you can get a maximum score of 1000. Ideally the project should have a low PDRI score. This represents a well defined project definition package, and in general, corresponds to an increased probability for project success. A PDRI score of 200 or less has been shown to greatly increase the probability of project success. Higher scores signify that certain elements within the project definition package lack adequate definition.
(Gibson & Dumont, 1996).

Independent Project Analysis (IPA) & Front End Loading (FEL)

IPA has conducted over 300 research studies whose findings are aimed to increase the level of understanding of what drives project success. All IPA's research studies are quantitatively based, linking capital project performance with a set of practices. The practices and learning's that result from IPA's empirical approach have been implemented by numerous organizations, including StatoilHydro to make improvements in their capital project systems (IPA, 2004).

IPA has gathered information from ca 10,000 projects executed worldwide. From this information IPA has developed detailed databases that contain data about the entire project life cycle from the business idea through early operations. They have used these data to develop statistical tools that enable them to compare project performance in different areas. The underlying principal of the models is that the outcomes of projects can be predicted by understanding the historical relationship between project drivers and the project's final outcome, (ibid).

IPA collects their information trough, workbooks, interviews and documentation of data. IPA workbooks are standardized questionnaires that are used to gather information about the project. IPA uses a five step procedure to gather information, analyse the project and present the results. The steps are:

Step 1: Workbooks are sent to team members so that they can fill them out. The workbooks involve the following major components:

- General information (project location, type, size)
- Technology (level of technical innovation)
- Project management (contracting strategy, team integration)
- Cost (estimated and actual costs, contingency)
- Schedule (planned and actual by phase, changes)
- Operational performance (planned and actual)
- Project definition (site-specific factors, project execution planning, completed engineering)
- Value Improving Practices (as applicable)

Step 2: IPA carries out an interview with the team members. The project team members that is interviewed usually includes project manager, process and lead design engineers, cost estimator, cost and scheduling engineer, research and development, operations, maintenance, and business representatives, (ibid). In these interviews IPA use the workbooks that are sent to the team members. The objective of the interview is to go through the different workbooks and discuss the answers that the project team has provided. The reason for this procedure is to make sure that the team members understand the questions right and that there are no gaps between what is discussed during the interview and what is answered in the workbooks. The IPA analyst also makes sure that all the sections and questions are answered.

*Step 3***:** IPA analyse the information that is gathered and use their database to compare the project with other similar projects.

Step 4: IPA present the results to the project team. The intention of the evaluations is to help the project team to assess the current status of the project and identify areas that needs attention during the remaining activities.

Step 5: A report is written

IPA's most significant contribution to understanding project management was in quantifying the relationship between project definition, Front-End Loading (FEL), and project outcome like safety, cost, schedule, and operability. Both, IPA and CII research indicates that FEL is the key ingredient in successful project delivery. Research shows that good FEL performance can improve overall project schedule and project cost performance by as much as 20 to 30 percent (Willink, 2005).

IPA's definition of Front-End Loading (FEL);

> *FEL is a measure of the level of definition of a project; FEL provides a picture of the project readiness for execution and level of risk.*

IPA breaks down their version of FEL into three categories: site factors, engineering status and project execution plan. These categories are further broken down into elements illustrated in figure 5.

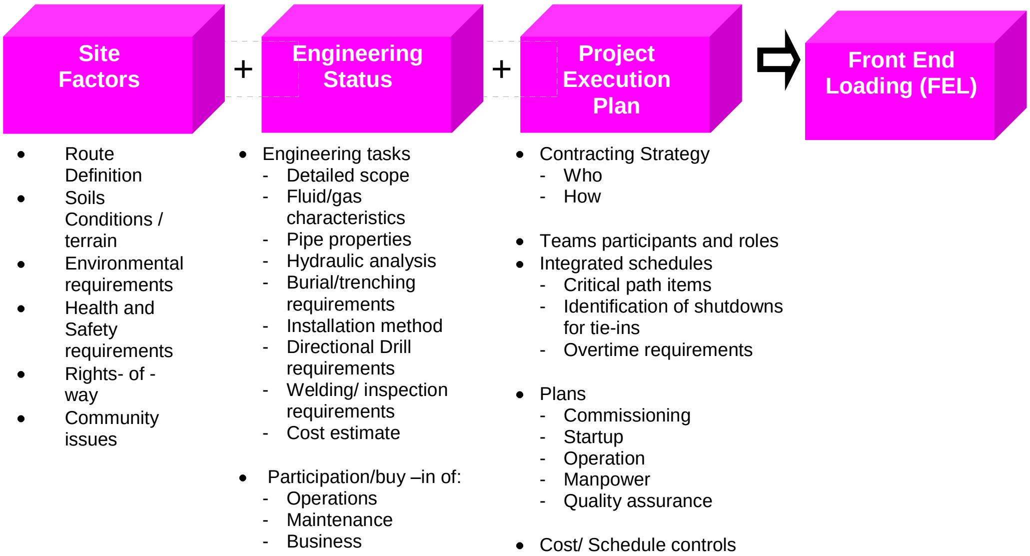


Figure 5 Main categories and elements of FEL adapted from (IPA 2009)

All FEL indices have a scale from 3.0 to 12.0, with 3.0 representing the most advanced level of definition and 12.0 representing just a sketchy outline of project intent with no formal definition work done. IPA has developed a range of *Best Practical* values at authorization to be in the range of 4.00 – 5.50 (Sandberg, 2008c). IPA research show that projects with good FEL exhibit better performance. The *Best Practical* values attend to be a target of the FEL score to increase the possibility of project success. The best practical range is marked with the green line in the figure 6.

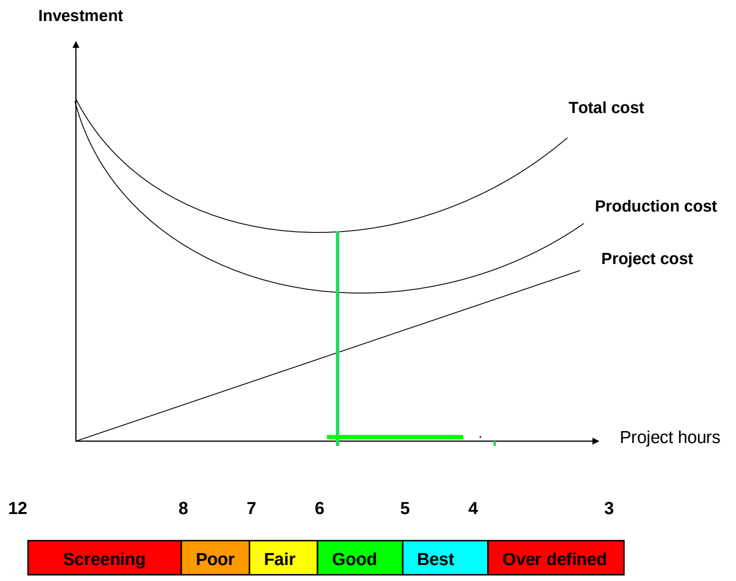


Figure 6 Minimizing the investments adapted from(Ø. Meland, 2008)

Figure 6 shows a project where the objective is to minimize the total investment cost. The vertical axis show investments and the horizontal axis show project hours. Project cost is a linear function of the project hours. If the hours that are used on the project increases, the project cost will increase. The production costs will decrease when the project hours increase because the project design more beneficial solutions or the project avoid, for example, late design changes etc. The production costs will only decrease until a certain point. There will always be a trade off between how much time the project want/can use in the planning phase and how much money they want/can use. Increased planning will reduce risk and uncertainty, but the project team will never be able to plan for everything and at some point the project have to say that the planning is good enough.

The objective of a project is to use as much time they need to find the optimal solution of the project, not to detailed so it get over defined nor to little so they just have a screening of the project solution. The project department in StatoilHydro has decided to aim for an average FEL of 5.50 for projects sanctioned. Currently Statoil average FEL for the last 10 years is above 6.00 which lies somewhere between fair and good definition of the project (Østrem, 2008).

FEL is, like PDRI one way of evaluating the maturity of a project at different stages before final sanction. The objective of FEL is to gain a detailed understanding of the project to minimize the number of changes during late phases of project execution (IPA, 2008).

IPA evaluates the projects in different stages of the project life cycle. In StatoilHydro they mainly perform four evaluations of each project. These include a pacesetter analysis, a prospective evaluation, a closeout evaluation and an operability evaluation. These four analyses provide the project team with an analysis of the project's drivers, outcomes and lessons learned from the project.

The pacesetter analysis is performed at the beginning of the definition phase of a project. The objective of the pacesetter analysis is to provide the project team with an early interpretation of the inputs and expected outcomes of the project. The analysis also provides specific recommendations for successful completion of the project definition phase (IPA, 2006).

The prospective analysis is performed near the end of the project definition phase of a project. The objective of this analysis is to assess the project's readiness to move into the execution stage.

A closeout evaluation is performed in the end of the execution phase and summarizes the performance of a completed project. IPA compares the performance of the project to similar projects in the industry and with the company's average performance.

An operability evaluation is performed one year after the project is completed. The objective is to evaluate the production attainment and provide lesson learned from the project, (ibid).

These evaluations are shown in figure 8 together with the capital value process.

IPA research shows that there are nine key drivers that contribute to project success. These drivers are included in the model; *a pathway to success*. This model is presented in chapter five and this model will be used in order to perform an empirical study of two of the key drivers that contribute to project success.

3.1 The Operating Model

The operating model is how StatoilHydro manage their performance. The objective is to support their people in making the right priorities (StatoilHydro, 2008c). The operating model is part of StatoilHydro's management system shown in figure 7.

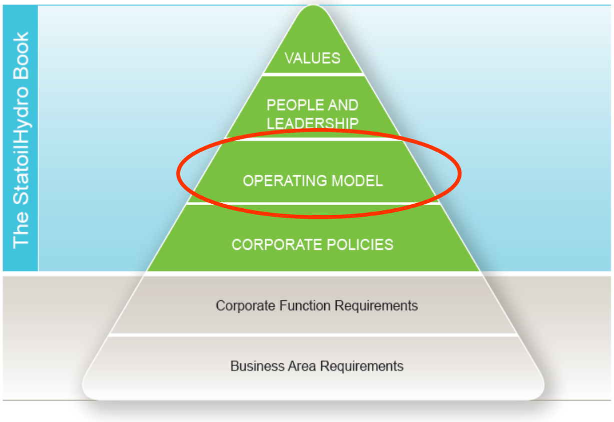


Figure 7 Management System (StatoilHydro, 2008c)

One of the important operating models is the Capital Value Process (CVP). This is StatoilHydro's stage gate decision process for investments. It is designed to achieve predictable and competitive investments, by integrating all functions into one effective process (StatoilHydro, 2008c). The aim is to develop a business opportunity into the most profitable operation for the total value chain according to the corporate requirements, (ibid).

3.1.1 Capital Value Process (CVP) and Decision Gates (DG)

The process provides an overall framework that evaluates the readiness and justification of a business case to proceed into the next phase. The main objective is to achieve similar handling of projects by using the capital value process to secure predictable and competitive investments (StatoilHydro, 2008b).

Each investment project runs through defined phases. Between each phase there is a Decision Gate (DG) that must be passed in order to proceed to the next phase. A decision gate is a milestone where a decision shall be made whether the project shall continue to the next phase which indicates that the DG is passed, needs future development which indicates that the project has to go back to the previous DG, or terminated which indicates that the project will have no further development (StatoilHydro, 2008b). Each decision gate is marked with a green arrow in figure 8.

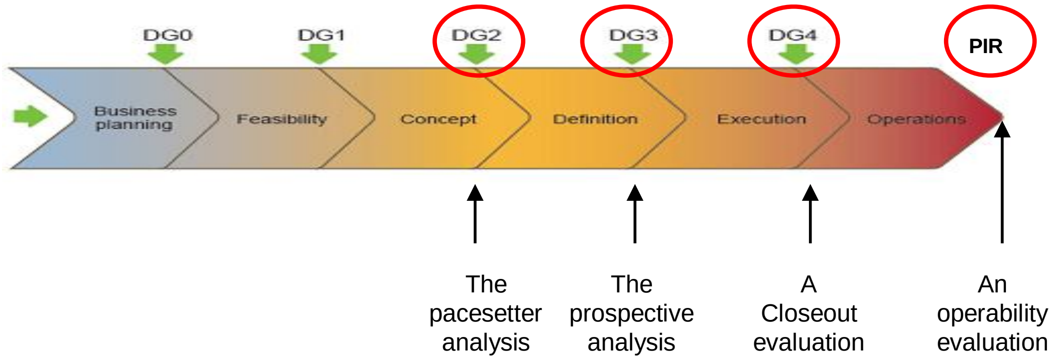


Figure 8 Capital Value Process (StatoilHydro, 2008b)

The first phase is business planning. The objective is to decide whether a project study should be established or not. To enter the next phase the project needs to pass DG0, which is an approval to establish an investment project and to perform feasibility studies.

The second phase is feasibility and the objective is to establish and document whether the development of a business opportunity is technically-, operationally-, and organizationally feasible. In the end of this phase the project needs to pass DG1. In order to pass DG1 the business concept must be developed to a level where it is likely to be profitable, technically and organizationally feasible, meet the required cost estimate accuracy, and is in agreement with corporate business plans and strategies.

The third phase is the concept phase. This phase shall provide a firm definition of the design basis and select the preferred and technical concept. The objective is to reduce the number of alternative concepts. DG2 may be passed when the selected business concept has been developed to a level where it is documented that it will be technically and operationally feasible, profitable, meets the required cost estimate accuracy and a project organisation is defined.

The fourth phase is the definition phase. The objective is to develop and document the business concept to such a level that sanction can be decided. This should also include the business concept for execution. DG3 may be passed when the total business concept has been developed and documented to meet the project execution requirements with regard to execution risk, schedule and cost estimate.

The fifth phase is the execution phase. This phase shall complete the project scope until ready for start-up. In the execution phase, the integrated project team shall normally design, construct, fabricate and assemble the facility, plan and execute drilling and completion activities, prepare for operations, and perform technical and mechanical completion as well as commissioning for operation or production for the business case (StatoilHydro, 2008b). DG4 may be passed when handover to operation has been completed and the business case is ready to start ordinary operation and all formal close-outs are preformed.

The last phase is the operation phase. After a defined period of operation, experience related to the design, construction and operation knowledge will be gained. Post Investment Review (PIR) will undertake an overall assessment of the business case, including assessment of actual performance for project execution and operation.

3.1.2 Main elements in every phase of the Capital Value Process

Figure 9 shows all the main elements that are included in every step of the capital value process. This includes stakeholders start-up meetings, risk management, Steering committee, internal bid committee, arena review and decision gate support package (Sanner, 2008).

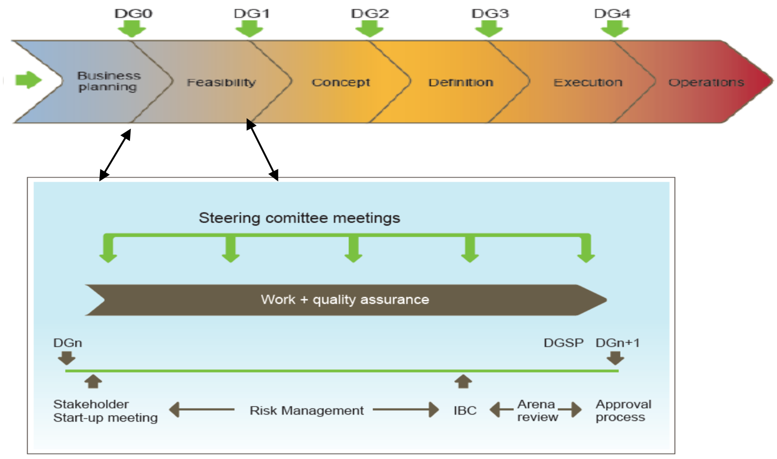


Figure 9 Main elements in every phase of capital value process (StatoilHydro, 2008b)

Stakeholder Start-up Meeting shall be held in each DG phase. The objective is to ensure a common understanding of the strategic fit of the business case, scope of work and necessary level of details that the different business areas has to perform.

Risk Management is a continuous process to identify and assess all the significant risks, (both upsides and downsides) risk, and then use this information to find a response action and a way to control the risk if possible.

The Steering Committee consists of key stakeholders that are appointed to follow up the project key issues agreed upon in the stakeholder start-up meeting.

Internal Bid Committee ensures alignment between relevant key stakeholders on procurement strategies as part of the project execution and overall procurement strategy (StatoilHydro, 2008b).

Decision Gate Support Package (DGSP) includes all relevant corporate requirements for an investment decision. This material is used as a basis for the investment proposal.

Arena review is an independent assessment of decision material (DGSP). The objective is to ensure that expectations regarding the end result and risk exposure are realistic and understood by the decision maker, (ibid).

3.2 Main Roles in Projects

The *asset owner* is the manager responsible and accountable for the business case and securing good and consistent investment project decisions. The asset owner is the one that makes the internal order of the project, who is financially and commercially responsible for making the business decisions in the project and approving decision gates (StatoilHydro, 2008c).

An *asset owner representative* will be appointed by the asset owner to follow up the investment project and will be responsible for securing necessary value chain assessments, on behalf of the asset owner, (ibid).

Project manager will be appointed to carry out an agreed scope of work for a defined part of the investment project, usually involving deliveries from a business area to the asset. This means that he is responsible for managing the project towards its goal. For one business case or investment project there might be several project managers responsible for different sub-projects, (ibid).

The project *team members* are responsible for executing the project in accordance with the specification made by the project manager, and for ensuring that the processes, methods and standards of the organization, are carried out accordingly.

3.3 The Business Areas

There are six different business areas in StatoilHydro. These include exploration and production Norway, international exploration and production, natural gas, manufacturing and marketing, projects, and technology and new energy.

Exploration and production Norway is responsible for the company’s exploration, development and production of oil in Norway.

International exploration and production (INT) is responsible for the company's exploration, development and production of oil and gas outside the Norwegian continental shelf.

Natural gas (NG) business segment transports, processes and sells natural gas from upstream positions on the Norwegian continental shelf and certain assets abroad. They are also responsible for liquefied natural gas and for international gas marketing.

Manufacturing and marketing (M&M) processes and sells StatoilHydro's and the state's crude oil and liquefied natural gas and is responsible for the company's overall operations relating to the transport of oil, refining, sales of crude oil and refined products, and for the retail business and the marketing of gas in Scandinavia.

Technology and new energy (TNE) is the centre of technology and new energy for global business success. Technology and new energy focuses on developing innovative solutions to protect the environment, finding more oil and gas, optimizing reservoir recovery, field development, transport systems, refining and processing, gas refining and technology management of new energy. Technology and new energy is the main supplier providing technical solutions, technical support and competence, personal and technical input to DG support packages.

Projects (PRO) is specialized on definition and execution phase. The objective is to deliver projects on time, cost and with high HSE standard and quality. Projects provide support within: estimate and planning, procurement, execution competence, contractor market knowledge and capital value facilitation (SH, 2009a).

3.3.1 Roles and Responsibilities

Figure 10 shows the three first steps of the capital value process: business planning, feasibility and concept phase. The figure shows the roles of the different business areas from DG0 to DG2. It is the asset owner (shown in red) and technology and new energy (shown in yellow) that are responsible for these faces. Projects (shown in green) will also assist with their competence if it is necessary in these early phases.

1 *Asset owner* is responsible for developing a business case through asset management, establish and manage the steering committee and establish cost limit. Asset owner will establish a written agreement with Technology and new energy. This agreement is called a *project charter* and regulates the responsibilities, authorities, scope, cost limit, schedule and deliveries.

2 *Technology and new energy (TNE)* is responsible for developing the *business opportunity* prior DG 2 by contributing with integrated technical solutions within facilities, subsurface and drilling and is in charge of concept development and arena review.

3 *Projects (PRO)* will assist Technology and new energy in project development of the business opportunity contributing with resources or dedicate deliveries. Projects will have a support function from DG0 to DG2. Additionally Project will facilitate the investment decision in the capital value process.

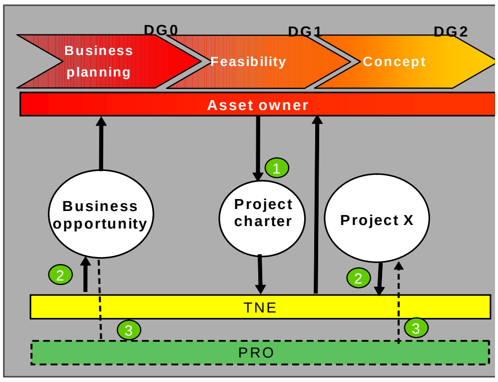


Figure 10 Roles from DG 0 to DG 2 (SH, 2009)

Figure 11 shows the three last phases in the capital value process: definition, execution and operation. The figure shows the roles and responsibilities from DG2 to DG4. The asset owner is responsible for these phases. Normally projects come in with their competence in DG2. Projects are then responsible for the definition and execution phase. Projects (PRO) can also support the *operations* (shown in beige) if this is necessary. Technology and new energy has a support function through the three phases. Operations support Projects from DG2 to DG4 and are responsible for the operation phase.

1 *Asset owner* has the same responsibilities that described above.

2 *Projects (PRO)* is responsible for project preparation and a holistic project execution until hand over of a complete project.

Asset owner will establish a written agreement with *projects (PRO)* regulating responsibilities, authorities, scope, investment frame, schedule and deliveries for project execution. In addition a short description of the hand over process and start of operation will be described.

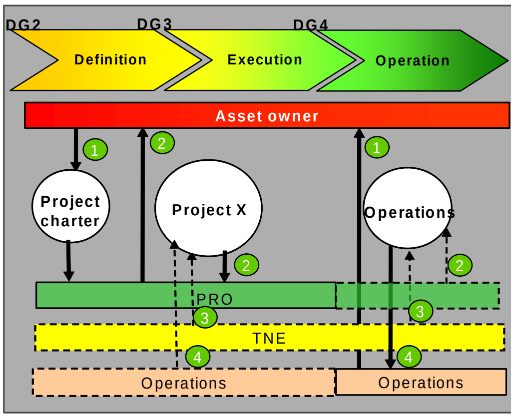


Figure 11 Roles from DG 2 to DG 4 (SH, 2009)

3 *Technology and new energy (TNE)* has a support function from DG2 to DG4 and contributes with qualified technical resources to *Projects (PRO).*

4 *Operations* shall contribute to *projects (PRO)* with qualified operations personnel in project execution. Operations are responsible for the operating of the facilities after DG4 (StatoilHydro, 2008a).

Chapter 4: Research Methods

4.1 Research Methods of the study

Research involves finding something new. Simply as meaning “new to everyone”, this is usually known as primary research. Alternatively it may mean “new to you”, this is usually known as secondary research (Rugg & Gordon, 2006).

Research methods can be seen as an organized and systematic way of finding answers to questions. *Systematic* suggests that research is based on logical relationships and not just beliefs (Ghauri & Grønhaug, 2005). *Answers to questions* suggest that there is multiplicity of possible purposes of the research.

We refer to the two key methods for research as qualitative and quantitative research methods. The use of each method depends on the nature of the research and the research question.

Van Maanen (1983) defines qualitative techniques as;

> *An array of interpretative techniques which seek to describe, decode, translate, and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world.*

Qualitative research methods aim to gather an in-depth understanding of the research question and the reasons that drive it. In collecting qualitative data there is no clear separation between collection of data, analysing, and the writing up process.

The aim of quantitative research is to:

> *Classify features, count them and construct statistical models in an attempt to explain what is observed* (Neill, 2007).

Quantitative research is a collection of mathematical and statistical techniques to analyse data in order to test empirical theories and hypotheses.

I have chosen to combine qualitative and quantitative methods. First, I have used a qualitative method to explore how the variables should be conceptualized for the quantitative method to be applied. My aim was to use unstructured interviews, participant observations and reviewing reports from different projects to get an understanding of IPA's model: *A pathway to success* and how IPA collects their information. Second, I have used the quantitative method for the purpose of understanding the relationship between targeting and project execution (independent variables) and cost and schedule performance (dependant variables). The statistical model that is used is a regression and a correlation analysis.

4.2 Research Design

A research design represents a plan or a framework for the study as a guide in collecting and analysing data.

> *There are no perfect research designs. There are always trade-offs. Limited resources, limited time, and limits on the human ability to grasp the complex nature of social reality necessitate trade-offs (Patton, 2002).*

It is usual to classify research design into three categories. These categories are exploratory, descriptive and causal.

Exploratory research design emphasizes on discovery of ideas, an insights which is especially useful when breaking a broad vague problem statement into a smaller and more precise research question. It is also useful in clarifying concepts and testing measurement methods.

Descriptive research design is typically concerned with describing the characteristics of a phenomenon. Descriptive research seeks to determine the answer to who, what, where, and how questions. It also estimates the frequency or proportion and association of variables or it makes some specific predictions (Rugg & Gordon, 2006).

Causal research studies attempt to identify a causative relationship between an independent variable and a dependent variable (Gay, Mills, & Airasian, 2006).

First, I studied different literature, read reports, presentations, and articles. Second, I used a descriptive research design were I described the model: *A Pathway to success*. Ten hypotheses based on theory and IPA's previous findings were formulated. Third, I used a causal approach in order to explore the relationship between the variables. A regression and a correlation analysis were used in order to test the hypotheses.

4.2.1 Participant Observations

The method of participant observation has its roots in anthropological research, where a key element of the research training involves living within societies in far away places and attempting to understand the customs and practices of these strange cultures. Since organizations can easily be viewed as “tribes” with their own strange customs and practices, observations have been used in organizational and management research.

Participant observation is an unstructured observation method. The researcher is part of the natural social setting that he/she is observing. The researcher enters the daily life or the natural situations of the informant he/she is studying, watches their behavior, their interactions, and events and situations around them. We can say that the researcher enters a “foreign” world with the aim of making that world understandable (Launsø & Rieper, 2007).

I have used participant observation of IPA’s interviews with team members. The objective was to observe and understand how IPA performs the interviews. I also used this method to gather information and perspectives from the team members about IPA and what they think about the construction of the interviews and the information that is gathered.

Participant observation was also used when I attended a StatoilHydro workshop. The purpose of this workshop was to discuss the recommendations to improve project performance that was highlighted on IPA conference 2008.

4.2.2 Unstructured Interviews

Interviewing is often claimed to be “the best” method of gathering information. Interviews can be highly formalized and structured, or they can be quite unstructured, free-ranging conversations. Unstructured interviews involve direct interaction between the researcher and a respondent group. The researcher may have some guiding questions or core concepts to ask about, but there is no formal structured instrument or protocol. The interviewer is free to move the conversation in any direction that catches his interest. The importance of interviews is summarized by Burgess (1982):

> *The interview is the opportunity for the researcher to probe deeply to uncover new clues, open up new dimensions of a problem and secure vivid, accurate inclusive accounts that are based on personal experience.*

In my study I have used face-to-face unstructured interviews. The primary purpose of these interviews was to understand the organization of StatoilHydro and how they make their decisions. Unstructured interviews were also used in order to understand IPA's model: *A pathway to success*.

4.2.3 Case studies

A case study design can incorporate qualitative as well as quantitative data. A case study can be defined as;

> *A strategy to investigate a complex phenomenon based on an in-depth understanding of the phenomenon that requires an extensive description, analysis and interpretation incorporating the wholeness of the phenomenon and the context in which the phenomenon is embedded (Launsø & Rieper, 2007).*

Case studies typically examine the interplay of variables in order to provide as complete understanding of an event or situation as possible. The weakness of case study designs is the concentration on one or a few phenomena, which means that you lose in breadth what you gain in depth.

I chose to focus on two of the nine drivers in IPA's model: *A pathway to success* in order to get an in depth understanding of these drivers. I have used 22 projects in my study to explore the relationship between the independent and dependent variables.

The observations, interviews and case studies were done in order to get a foundation that I could use to develop the hypotheses. Hypotheses are empirically testable statements about the relationships between concepts. I have developed ten hypotheses that are based on theory and IPA's previous findings. A regression and a correlation analysis are conducted in order to explore the relationship between the independent variables and the dependent variables.

4.2.4 Regression Analysis

Regression analysis is a statistical technique used to explore the relationship of a dependent variable and one or more independent variables. I am going to use a simple linear regression. The simple linear regression uses two variables and attempts to identify the relationship between an independent variable X, called the predictor, and a dependent variable (Y). This can be represented visually as the attempt to draw the best straight line through a number of points plotted onto a graph.

The simple regression model is a bivariate linear regression:

$Y = \alpha + \beta X + e$

Where:

Y = the dependent variable

X = the independent (predictor) variable

α = the Y intercept

β = the slope coefficient of the relation

e = the residual[3]

(Bryman & Bell, 2007)

The residual is based on the mean distance between the line and each point, and it is important since it indicates the strength of association between X and Y. If the points on the scattergram are spread widely, then the residual will be high and hence the correlation between the two variables will be low. If the points cluster closely along the line then the residual will be low and the correlation between X and Y will be high.
(Easterby-Smith, Thorpe, & Lowe, 2002)

The objective of the simple regression analysis in my study is to test the hypotheses and decide if I can support or not support the hypothesis. I need to define decision criteria's in order to decide. These are:

Multiple R represents the strength of the linear relationship between the actual and the estimated values for the dependent variable. The scale ranges from -1.0 to 1.0 where 1.0 indicates a good fit. If there appears to be a random scatter of point, we might expect to get a correlation which is close to zero. An "uphill" slope ties in with a positive correlation coefficient and a "downhill" slope with a negative correlation coefficient. The closer to a straight line the points lie, then the closer to either + 1 or -1 the correlation coefficient should be.

R-Square tells us how much of the variability in the dependent variable is explained by the independent variable. R-Square can vary from 0 to 1, were 0 indicates that the dependent variable explain 0 % of the variance in the dependent variable. If R square has a value of 1, it indicates that our independent variable explains 100% of the variance in the dependent variable. There is no rule for what a good value for R-Squared should be. This

[3] Difference between the actual and estimated value of the dependent variable

depends on how you measure it and what you measure. In my study I am looking at a situation were there are many possible predictors, and I am only analysing parts of these. Therefore it will be very rare to get an R-Square that is larger than 0, 5. Holme & Solvang (1996) argues that R^2 larger than 0, 5 is rare in research methods unless we are talking about tautologies[4]. In my statistical analyses R-Square close to 0, 1 will be interesting.

When a small sample is involved, the R-Square value intends to be a rather optimistic overestimation of the true value. *Adjusted R-Square* statistic “corrects” this value to provide a better estimate of the true value. It shows how well the model fits the whole population and not only my sample. I will therefore present the adjusted R-Square in my results.

The *Standard Error of estimates* is a regression line. The error is how much the research is off when using the regression line to predict particular scores. The standard error is the standard deviation of those errors from the regression line. The lower the standard error of estimate is the higher degree of linear relationship between the two variables can be observed in the regression. The larger the standard error, the less confidence can be put in the estimate.

Significance level tells us whether this variable is making a statistically unique contribution to the equation. The level of significance does not indicate how strongly the two variables are associated, but it indicates how much confidence we should have on the results obtained (Pallant, 2007). If the significance level is very high this indicates that the observed differences are due to random factors. If the significance level is very low, we can rule out the possibility that the results are caused by random factors with some degree of certainty.

The standard level of significance used to justify a statistically significant effect is 0.05. This indicates that the results have a 5 % chance of not being true and 95 % chance of being true. The 95 % level comes from academic publications, where a theory usually has to have at least 95 % chance of being true in order to generalizing research findings. If a test shows a significance of 0.06, it means that there is 94 % chance that the results is true and not caused by random factors. You can not be quite as sure about the results as if the results had shown a 95 % chance of being true, but the odds still are that it is true. The significance is strongly influenced by the size of the sample. If you have a small sample it might be hard to reach a 95 % significance level. In the business world if something has a

[4] Tautology = Explain a phenomenon by the phenomenon itself.

90 % chance of being true, it can not be considered proven, but it is probably better to act as if it were true than false (Thesurveysystem, 2009). In my research I have a sample of 22 projects. This is too small in order to generalize the research findings and it will be hard to reach a significance level of 95%. I will use a significance level on 90 %, this means that I can not prove the results that reach this level, but I can indicate the relationship between the variables.

4.2.5 Correlation Analysis

Correlation analysis is used to describe the strength and direction of the linear relationship between two variables (Pallant, 2007). In my statistical analysis I have used two types of correlations: *Simple bivariate correlations* with the purpose of explore the relationship between two variables. And *Partial correlations* with the purpose of explore the relationship between two variables, while controlling for another variable.

The result from these analyses gives us Pearson correlation coefficients (r) which can only take the values from – 1 to + 1. The + sign indicates that there is a positive correlation between the variables. This means that if one of the variables increases, the other variable will also increase. The – sign indicates that there is a negative correlation between the variables. This means that if one of the variable increases, the other variable will decrease. The size of Pearson correlation coefficient (r) provides an indication of the strength of the relationship. A perfect correlation of 1 or – 1 indicates that the size of one variable can be determined exactly by knowing the value of the other variable. A correlation of 1.0 indicates a perfect positive correlation, and a value of – 1.0 indicates a perfect negative correlation. A correlation of 0 indicates no relationship at all. This means that the value of one of the variables provides no assistance in predicting the value of the second variable, (ibid).

The challenge is how to interpret the variable between 0 and 1. Different authors suggest different interpretations. Cohen (1988), suggest the following guidelines:

Small correlation between the variables that has r = .10 to .29
Medium correlation between the variable that has r = .30 to 49
Large correlation between variables that has r = .50 to 1.0

I will use these guidelines when I interpret the results from my correlation analysis.

4.3 Validity and Reliability

Validity and reliability are two related research issues that ask us to consider whether we are studying what we think we are studying and whether the measures we use are consistent. Text books often distinguish between two main kinds of validity: internal and external validity.

Internal validity is the approximate truth about interfaces regarding causal relationship (Trochim, 1999). The key questions in internal validity are; can the observed changes be attributed to the program that is used? And can there be alternative explanations for the outcome? In my study I have only analysed some of the variables that influence project success; there will be other variables that influence project success as well. The interpretation of the results is also critical. Some of the results were hard to interpret and there is a risk that I might have misunderstood some of the results or that somebody else would interpret the results differently. This could weaken the internal validity of the results.

External validity involves the extent to which the results of a study can be generalized. In other words, can the results of the study be applied to other people or settings? I have only studied a sample of 22 projects in the oil and gas industry. This sample is too small in order to apply the results in other settings. Therefore I will argue that the external validity is weak and I will not be able to generalize the results.

Reliability is the extent to which an experiment, test, or any measuring procedure yields the same results on repeated trials. It refers to the ability to provide consistent free from error results (Carmines & Zeller, 1979). In my research I have used reports from IPA to gather data for the statistical analysis. This data have been used uncritical, and I have not controlled these data against other documents. I also had problems with outliners in some of the analysis; these outliners can influence the research and negatively affect the reliability of the results.

I have mainly used Excel to perform simple and multiple regression analysis. I repeated some of the analysis by using SPSS and got the same results. I also performed a correlation analysis in SPSS to control the relationship between the variables; this strengthens the reliability of the statistical analysis.

4.4 Ethical Concerns

According to Punch (1986) ethical issues frequently arise from a clash between personal and professional interests. It is important that the researcher do not overstep the bounds of personal privacy or confidentiality. Discussions about research ethics are most frequently held in relation to the use of qualitative methods. This may be simple because qualitative researchers are more sympathetic and sensitive to human feelings and responsibilities. On the other hand, it may be that when using qualitative methods, such as open interviews or participant observation, the researcher has far more control about what information is gathered, how it is recorded, and how it is interpreted. With quantitative methods it is generally the informant who provides the information directly, through completing questioners or whatever, and the researcher simply has to accept what is provided by the informant without having much opportunity to question it. Another ethical issue is around the control and use of data obtained by the researcher. The researcher must exercise due to ethical responsibilities by not publishing or circulating any information that is likely to harm the interests of individual informants.

4.4.1 Confidentiality in StatoilHydro

The duty of confidentiality should prevent unauthorised persons from gaining access to information that may harm StatoilHydro's business or reputation. This duty should also protect individuals' privacy and integrity. Careful consideration should therefore be given to how, where and with whom StatoilHydro-related matters are discussed, in order to ensure that unauthorised persons do not gain access to internal StatoilHydro information. The individual must comply with the requirements for confidential treatment of all such information, except when disclosure it authorised or required by law.

Information classified as "confidential" or "StatoilHydro internal restricted distribution" must not be disclosed to unauthorised personnel in StatoilHydro. This also applies to sensitive information concerning security, individuals, technical or contractual matters and to information protected by law. Information other than general business knowledge and work experience that becomes known to the individual in connection with the performance of their work shall be regarded as confidential and treated as such (SH, 2009b).

I have used models and reports provided by StatoilHydro and Independent Project Analysis (IPA). These documents are confidential. However there is not possible to identify single projects in this thesis. I will also argue that the information that is provided can not harm StatoilHydro's business or reputation. Therefore I can not find sufficient reasons for not making the master thesis publicly assessable and therefore will be open to the public.

PART III: THE MODEL

Chapter 5: Building a pathway to success

5.1 Project Drivers

A project driver is practices that drives project's performance (Østrem, 2008). To avoid any confusion project drivers is the same as success factors explained in the literature review.

IPA has gathered project information and performance and found statistical relationships between important drivers that influence the project outcome (Østrem, 2008). IPA has developed a model called *a pathway to success* with 9 key drivers that affect the asset outcome. The drivers are; 1) Reservoir complexity, 2) Appraisal strategy, 3) Reservoir front-end loading, 4) Scope and technology, 5) Team integration, 6) Well front-end loading, 7) Facilities front-end loading, 8) Target setting and 9) Project execution discipline.

The objective of this model is to help clients to better understand the project outcomes by understanding the factors that drives the outcome. The reason why IPA focus on the drivers is because they are the factors that either the team needs to be aware of when assessing project economics or factors the team can change to improve the likelihood of project success (IPA, 2007b).

In the model *a pathway to success* IPA has divided the Front-End Loading (FEL) component into three disciplines. One FEL for reservoir, one FEL for well construction and one FEL for the facilities (Sandberg, 2008c). These FEL components are broken further down into categories that are broken further down into elements. IPA has also included asset FEL which is a combination of the three disciplines FEL used to benchmark the asset as a whole. A model that shows all the categories and elements of FEL is shown in Appendix B.

Figure 12 present the nine drivers that influence the project outcome. I have also included the capital value process to show which phase the success drivers are important. I have shown when IPA comes in and do their evaluations. The different evaluations of the project are shown with arrows underneath the capital value process. The drivers are shown in blue and the outcomes are shown in grey. The drivers are:

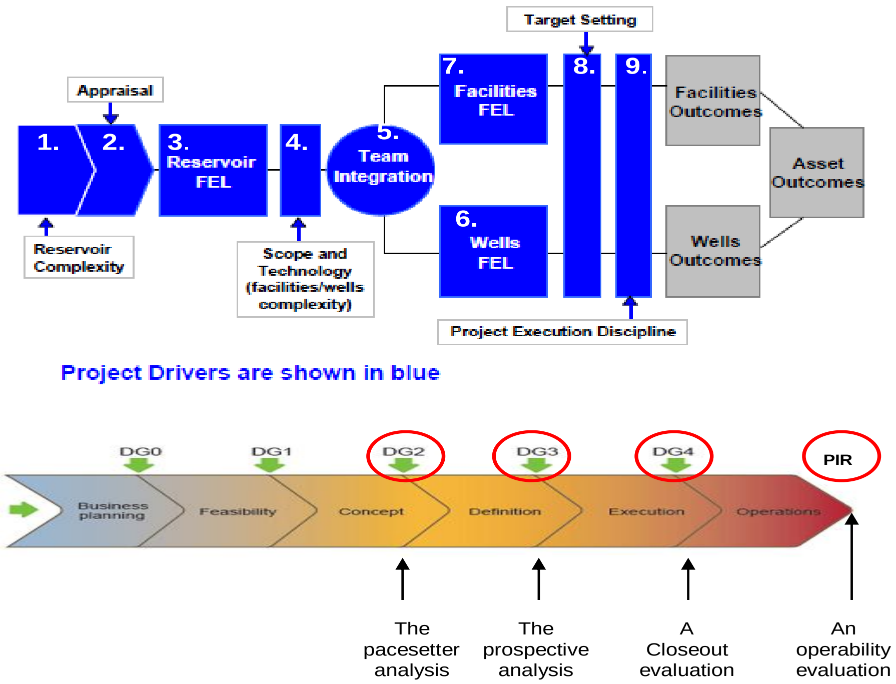


Figure 12 A Pathway to success adapted from (IPA, 2007a)

1. Reservoir Complexity

This is what nature provided and tells us about the characteristic to the reservoir. It is important to get a good understanding of the reservoir and reduce the uncertainty as much as possible. If the projects do not understand the reservoir appropriately the projects are set to fail. The understanding of the reservoir depends on which appraisal strategy that is chosen.

2. Appraisal Strategy

Appraisal Strategy is a factor that affecting both project drivers and project outcomes. The objective of the appraisal strategy is to gather as much information as possible to define the reservoir and reduce the uncertainty. The appraisal strategy tells us how many wells the projects want to drill in order to gather this information. IPA operates with three categories of appraisal strategies. These are aggressive, moderate and conservative. If projects use an *aggressive* appraisal strategy they drill few wells and use data that they have from other projects. This is typically if they have a reservoir that is very similar to projects they have done before. If projects use a *moderate* appraisal strategy they have some data available from earlier projects that is not fully representative for this particular project. Therefore they can use some of this information, but have to gather some new information. If projects use a *conservative* appraisal strategy they drill many wells. In this way they gather more accurate information about the reservoir and reducing the uncertainty. Using a conservative appraisal strategy is expensive because to drill a well is expensive. However the risk connected to the reservoir is reduced and projects can save money in later phases. With an aggressive appraisal projects might save money in the early phases, but this includes a higher risk an uncertainty. Which strategy that is chosen is a weighing between how much risk and uncertainty the projects are willing to take and how much money the projects want/can spend.

As shown in the pathway to success, everything stems from good understanding of the reservoir complexity and doing appropriate appraisal for the reservoir. If the project fails to understand the reservoir appropriately, the projects are set to fail. The reason for this is that every box/step the project do after appraisal builds on how well the reservoir is understood (IPA, 2007a).

3. The Reservoir Front-End Loading

The reservoir FEL tells us about the level of reservoir definition and how good the reservoir-data is interpreted. In other words the reservoir FEL tells us the quality of the data that was gathered from the appraisal strategy. The question is if the projects have the data they need for good and complete reservoir understanding or not (IPA, 2007a). A good FEL represents that projects have the information they need about the reservoir and the projects do not have a lot of uncertainties. This are often connected with a conservative appraisal strategy. A bad FEL represents that projects have an incomplete reservoir understanding and there are a lot of uncertainties tied up to the reservoir. This are often connected to an aggressive appraisal strategy. If the projects fail to understand the reservoir characteristic they are unlikely to design the optimal facility or well program to produce the resources found in the reservoir.

The reservoir FEL is broken into four categories and they are;

1. *Inputs* cover the comprehensiveness and quality of data available for reservoir evaluation.
2. *Constraints* identify and determine the effect of any issues that prevent a systematic reservoir evaluation or that restrict production, and the level of preparedness to overcome these issues.
3. *Tasks* include the status of the analysis, modelling and interpretation of the input data.
4. *Reservoir Evaluation Execution Planning* is the factors that assess the state of readiness of execution plans in three areas; team interaction, plans and documents and controls.

4. Scope and Technology

The introduction of new technology is risky and drives project performance. New equipment reflects uncertainties and is dependent of testing and proving the technology. This can be a challenging task and will have an influence on cost, schedule and production attainment. The advantage of new technology is that this can help the company to get a competitive advantage and reduced costs and increase income in the long run.

IPA looks at the level of technical innovation of facilities and wells and has categorized the new technology into five different levels. The levels are: *Routine* represents no new technology. *Minor modifications* represent the extension of known technology, some innovation are made. *Major modification* involves significant extensions of known technology and requires new engineering methodologies, construction techniques, or materials. *Substantial modification* requires that the project develop new technology to meet the overall needs of the system. Fundamental system design is still within the scope of existing technology. *New technology* represents that the project incorporates new and radically different system design (Gachter, Nandurdikar, & Rosenberg, 2008).

IPA also looks at the level of team experience with the new technology. These are also divided into different levels: *Routine* represents that there are no new knowledge that is required to implement this project. The project team has experience with this technology. *New to the team* represents that the technology is considered conventional in the industry and has been previously used in the company and the business unit. The project team lacks direct experience with this technology. *New to the business* unit represents that there are no new knowledge employed in the project. This technology is conventional within the industry and the company, but has not been used by the business unit before. *New to the company* represents that the technology that the projects are going to use has not been previously employed by the company. *New to the industry* represents that the technology used has not been previously employed by the industry (Gachter, et al., 2008).

5. Team Integration

An important driver for project success is to choose the most effective team with the right competence and experience. It is important with integration of the different business areas. Figure 13 shows the different business areas that have to be included in order to have an integrated team. An integrated team includes a team of full- or part time representatives of the following areas; Reservoir, Contractor, Planning & Scheduling, Business, Engineering, Construction, Maintenance, Operations/Production and Health & Safety. It is also important that the project team have specific responsibilities that are defined and understood by all the team members.

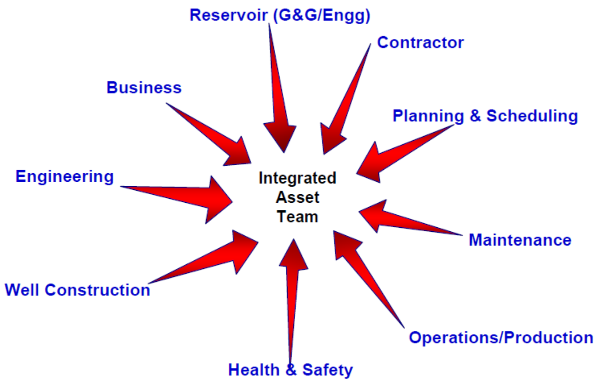


Figure 13 Integrated Team(Gachter, et al., 2008)

6. The Well Construction Front-End Loading (FEL)

Well construction FEL is a measure of the definition and planning of a project well program before authorization. The well construction FEL is determined by the quality of work done and the degree of risk and uncertainty reduction in four areas (IPA, 2003). These areas are;

1. *Scope of work* considers the interaction of drilling with the reservoir and facilities teams, as well as the degree to which local conditions are known.
2. *Regulatory/Health, Safety, and Environment* considers the status of regulatory permitting, health, safety, and environmental plans, including plans for conducting HAZOP reviews and drilling waste disposal.
3. *Well Engineering* considers progress on “traditional” well and completion design activities.
4. *Well Project Execution Planning* considers the readiness of the execution plans.

7. The Facility Front-End Loading (FEL)

Facility FEL is a measure of the definition and planning of the facilities. The project team needs to understand the reservoir characteristic to design the optimal facility or well program to produce the resources found in the reservoir. To what extent the reservoir uncertainties are communicated to the facilities team members is very important for project success (Sandberg, 2008a).

The three components of facilities FEL are;

1. *Site Factors* takes into consideration the physical site, various political and community issues by operating in its location or region.
2. *Engineering* status is characterized by the level of total engineering completed plus the amount of owner/operator input into the design. The reason that they look at

the owner/operator input is because the potential of design changes increases if the owner/operator have not contributed to the design.

3. *Facility Project Execution Planning* includes three separated but related items:
    a. Composition of the full project team
    b. Details of the planned contracting strategy for the project
    c. Development of a detailed and integrated project schedule

8. Target Setting

Competitive targets are said to be necessary to achieve competitive project performance. Targets should be reasonably aggressive and should be based on data and adequate definition. The organization can set performance targets higher or lower than is desired. Conservative targets increase the probability of target achievement and make it possible for the project team to achieve their targets with less effort. Aggressive targets give the project team a challenge to improve project performance. The team has to increase their effort in order to achieve the aggressive targets (Merchant & Stede).

9. Project Execution Discipline

Project Execution Discipline is practices in the project execution phase that drives projects performance (Østrem, 2008). IPA evaluates execution discipline, which comprises several key factors that plays a role in a successful execution of projects. This includes project control as measured by the Project Control Index (PCI), team development as measured by the Team Development Index (TDI), the incidence of key team members turnover and the frequency and impact of major late design changes (IPA, 2007a). The project execution discipline also includes Value Improving Practices (VIP).

9a) Project Control Index (PCI)

To achieve high probability of success, organizations must maintain good project control. Good control means that management can be reasonably confident that no major unpleasant surprises will occur (Merchant & Stede).

The Project Control Index (PCI) measures the set of practices a project team has to deal with in order to manage (or plans to manage) cost and schedule performance during the Front-End Loading (FEL) and execution phase of a project. The objective of project control is to establish and maintain a disciplined approach to manage work activities during execution so that planned project outcomes are achieved. First, effective cost and schedule performance plans are established. This includes planning, estimating for project cost, and scheduling a finish date for the project. Second, the project performance is measured against the plans that are made and evaluated. The objective is to measure the progress and forecast further development. If the measures indicate a deviation from the plan or a deviation is likely to occur, corrective action is taken. This is called change management.

PCI includes two components:

1. *Estimating for Control* measures how definitive project estimating methods were and how the estimate quality and effectiveness were validated.
2. *Control during Execution* measures the extent to which physical progressing was used, the extent of project status/progress reporting, and whether an owner project control specialist was assigned to the project during the execution. It also includes the extent to which historical cost data were captured in a database for future planning (IPA, 2007a).

The PCI is rated at four levels: good, fair, poor, and deficient. A *good* rating indicates that all of the elements for effective project control are in place or were used with fairly robust methods, detail, and so on. A *fair* rating indicates that one or more of the elements is not in place, was not used or that the methods and detail employed were not robust. A *poor* rating indicates that several of the elements for effective project control are missing or were not used. A *deficient* rating indicates that the elements for effective project control are not in place or were not used.

9 b) Team Development Index (TDI)

The Team Development Index (TDI) measures whether business objectives have been translated into project objectives, whether all necessary functions are represented on the team, whether roles, responsibilities, and tasks have been assigned an agreed to, and whether a common project implementation process is in place to serve as a guide for project team activities (IPA, 2007a). The four components of Team Development Index are shown in figure 14.

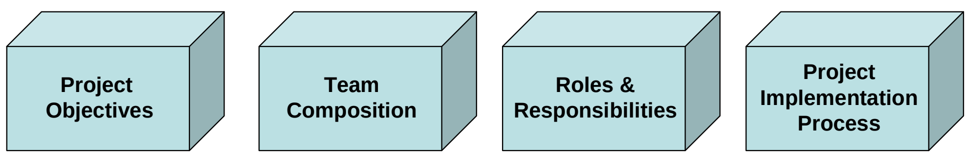


Figure 14 Components of Team Development Index (Sandberg, 2008b)

Project Objectives measures whether the project has established objectives, how well the business objective have been translated to project objectives, and how well the team understand the project's objectives.

Team Composition measures whether the team includes representatives from all functions that can influence the project's outcomes. IPA defines an "Integrated team" as a team of full- or part-time representatives covering all key disciplines.

Roles & Responsibilities includes whether roles for team members have been defined for team members, whether problem areas have been identified in advance, whether plans are being developed to address these problem areas, and whether the team is aligned on the project's objectives and tasks.

Project Implementation Process measures whether a common company project implementation process is in place and understood by the team.

TDI ratings are Good, Fair, Poor, and Undeveloped*.* A *good* rating indicates that all the factors of the index are in place. A *fair* rating indicates that at lest one of these four factors is not yet completed. A *poor* rating indicated that one or more of these factors are missing. An *undeveloped* rating indicates that a project team is not in place (Sandberg, 2008b).

9 c) Project Manager Turnovers

Project Manager Turnover tells us whether the person that lead the day-to-day responsibilities are changed during project definition and execution phase.

9 d) Changes

Change in projects is defined as a deviation from the planned (authorized) kit or configuration of kit in a project (IBC 2009, IPA). IPA breaks down the changes into three categories. These are:

Design change is defined as modification to the intended configuration that does not involve change in functionality or objectives. If the change is done to meet the original business intent, then it is a design change.

Scope change is defined as modification caused by change in objectives or desired functionality. This could be scope additions or scope deletions.

A change is *major* if the estimated cost is greater than 0, 5 percent of estimated total cost or is expected to cause a change of 1 month or more to schedule.
(ibid)

9 e) Value Improving Practices (VIP)

According to IPA Value Improving Practices is;

> *Out of the ordinary practices used to improve cost, schedule and reliability of capital projects.*

Value Improving Practices (VIPs) are disciplined practices that tend to improve the value of capital projects. Certain VIPs are more suited to particular disciplines than other (IPA, 2007b). VIPs are formal, documented practices involving a repeatable work process with measurable results. There are dozen of special practices used in the industry that are possible VIPs such as team building, peer reviews, etc. Only practices with a demonstrated, statistically reliable connection between use and better outcomes are determined as VIPs (Lavingia, 2007).

There are 16 Value Improving Practises that has been identified and is routinely benchmarked by IPA (IPA, 2009). IPA gathers information about which of these VIPs that is applicable/ not applicable for the particular project. Then they look at how many of the applicable VIPs the project team has used.

Example: A project has 12 applicable VIPs and the project team used 9 of these. This means that the team took advantage of 9/12 = 75 percent of the VIPs opportunities.
A complete list of the VIP practices and explanations are shown in Appendix C.

5.2 Project outcomes

The project outcomes are the result from the project drivers and execution discipline. IPA looks at the key project outcomes and compares the planned outcomes with the industry average outcomes for comparable projects. IPA uses several measures of performance to ensure that one area is not compromised to achieve results in another area.

The key outcomes IPA measures are cost, schedule, HSE and production attainment. IPA looks at the facility and wells outcomes to measure if the project delivers what they promised. Completing a project on time and within cost will not benefit the business unless operation is satisfactory and the value of the reservoir is released. Therefore it is the asset outcome that measures the projects success. Asset outcome is measured after the project is finished and represents production attainment.

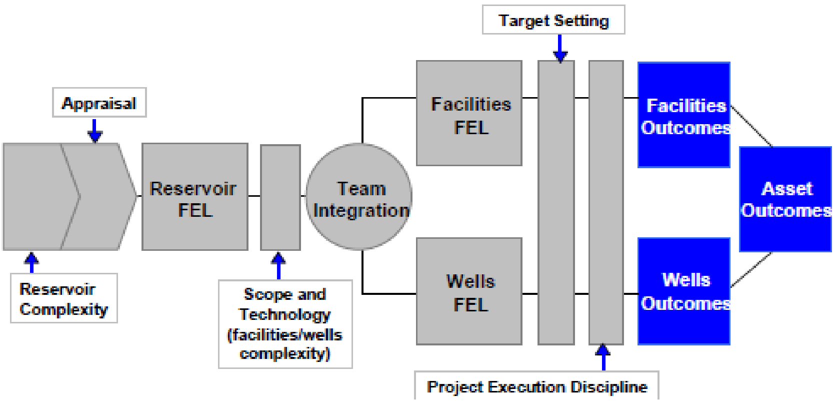


Figure 15 A Pathway to Success (IPA, 2007a)

Figure 15 shows the nine drivers of success that are explained above. These are shown in grey and are the nine drivers that IPA claims are the pathway to success. These nine factors drive the project outcomes which are divided into facilities outcomes and wells outcome. From these two outcomes the figure shows the asset outcome. The asset outcome indicates the overall outcome of the project. The outcomes are shown in blue in the figure.

Chapter 6: Hypothesis & Data Analysis

6.1 Development of Hypotheses

This chapter presents my empirical research study. In order to answer my research question, I have developed ten hypotheses that are presented in this chapter. A regression and a correlation analysis are conducted to explore the relationship between the independent and dependent variables in the hypotheses.

I have chosen to focus on two of the nine critical success factors in IPA's model; *a pathway to success*. The two success factors are target setting and project execution discipline shown in figure 16.

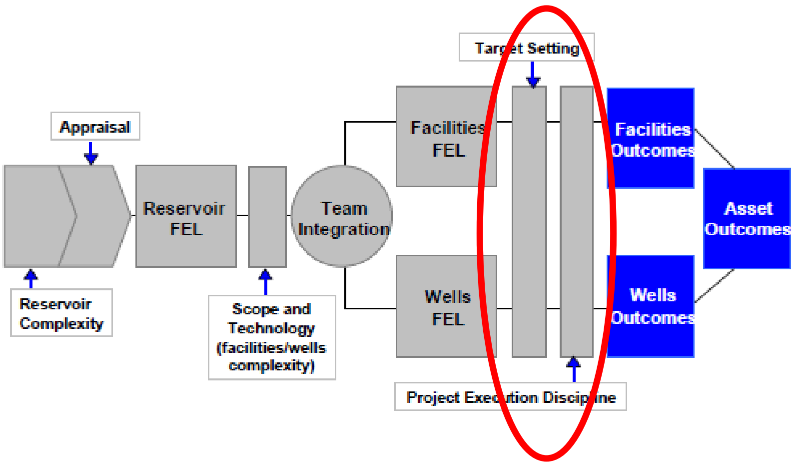


Figure 16 Focus areas for the analysis

All the other factors are not included in this analysis. The reason for excluding these factors is that IPA includes more than 2000 variables in the model. It was not possible to perform a research of all these variables because of limited time. Therefore I chose to focus on two critical success factors. The reason why I chose target setting and project execution discipline is that I find these areas very interesting and they are important for project management.

The independent variables that I am going to look at are 1) target setting, 2) project control index, 3) team development index, 4) project manager turnovers, and 5) major late changes. The dependent variables that I am going to look at is 1) cost gap and 2) schedule gaps.

IPA divides *target setting* into conservative, average and aggressive. The targets that are sat by each project are compared with the industry. If the project has set aggressive targets, the project has ambition to perform the project faster and to less cost than the industry. There is an increased risk associated with these estimates. The team might have to increase their effort in order to achieve the aggressive targets, which could again improve performance.

If the project set conservative cost and schedule targets, the project want to ensure that the cost and schedule estimate are not overrun. Research shows that conservative targets increase the probability of target achievement, and make it possible for the project team to achieve their targets with less effort. When conservative targets are compared with the industry, similar projects are usually performed faster and less expensive.

Hypothesis 1:

> *There is a negative relationship between conservative cost targets and predicted cost over run.*

Hypothesis 2:

> *There is a negative relationship between conservative schedule targets and predicted schedule over run.*

Project execution discipline includes project control index, team development index, project manager turnover and major late changes. *The project control index* focuses on discipline during execution for both cost and schedule. IPA research shows that projects with strong project cost and schedule control practices have more predictable and effective cost and schedule outcomes.

Hypothesis 3:

> *There is a negative relationship between good project control and predicted cost over run.*

Hypothesis 4:

> *There is a negative relationship between good project control and predicted schedules slips.*

IPA research presented at the Industry Benchmarking Consortium, (IBC 2001) showed that *team development* drives cost performance and execution schedules. When individuals, groups and companies interact as in project work, performance depends on how effectively they work together. The team cooperation can vary considerably, and studies show that this relationship will to a large extent, determine the performance of the organizational unit.

Hypothesis 5:

There is a negative relationship between good team development and predicted cost over run.

Hypothesis 6:

There is a negative relationship between good team development and predicted schedule slips.

IPA has observed that *project manager turnover* is disruptive to projects. Typically during turnover there is no overlap between the tenures of the outgoing and incoming individual. This leads to an inefficient transfer of learning and knowledge from old to new team members. Most likely will this disruptions lead to cost overruns and schedule slips. Another affect from *project manager turnover* is an increased possibility for scope and design changes. The reason for this is that the new manager might be unhappy with the program he has inherited and wants to do changes. These changes will most likely influence cost and schedule performance.

A study of project manager turnover conducted by S. K Parker & M. Skitmore, (2003) claims that:

Project management turnover directly affects the project team, negatively disrupting project performance and potentially affecting the profitability of the organisation.

Hypothesis 7

There is a positive relationship between project manager turnover and cost overrun.

Hypothesis 8

There is a positive relationship between project manager turnover and schedule slip.

When it comes to projects, there is a huge possibility that something unpredictable happens and *Changes* occurs. This can be due to project manager turnover, environmental changes, scope changes, contractor changes etc. These *changes* may increase the work required and the project team need to do rework which again affects cost and schedule.

Hypothesis 9

There is a positive relationship between major late changes and cost over run.

Hypothesis 10

There is a positive relationship between major late changes and schedule slips.

Often it is not possible for a project to achieve all their success criteria. The projects have to rate which of the criteria that is most important. This is often a ranking between cost, schedule and quality of the project. If the project chose schedule as their most important criteria, the project might have to overrun their cost estimates in order to achieve planned schedule. The reason for this is that the project might need more resources in order to reach their schedule target. This will again increase the cost of the project. The projects that chose cost as their most important criteria might have to increase schedule duration in order to keep the cost down. If the project chose quality as their most important criteria they might have to increase both cost and schedule in order to reach the highest quality.

These ratings are not taken into consideration in the hypotheses or the analysis that is conducted. I have only been looking at the projects cost and schedule overrun. I have not looked at the reason for the cost overrun could have been due to the fact that they reach their schedule. Or that the reason for the schedule overrun is that they reached their cost estimate.

6.2 Regression & Correlation Analysis

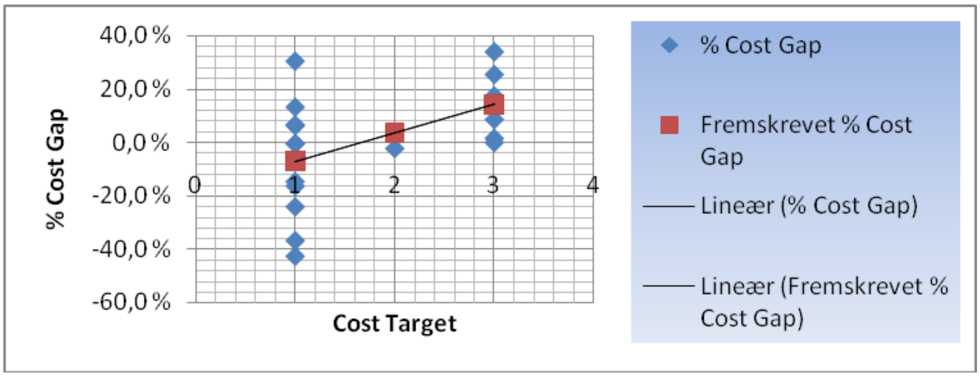
In this section I have analysed the independent variables prediction on cost and schedule by using a single standard regression and correlation analysis. My sample includes 22 projects that have cost ranging from NOK 400 million to NOK 40 000 billion. Five of the projects in my portfolio are not finished. To look at the cost gap in these projects I have used the last available estimates which are for March 2009. I was not able to get the latest schedule estimates on these projects. Therefore when I am looking at the relationship between the independent variables and schedule gap there will only be 17 projects included in these analyses. Another reason for the variation is that I did not have complete information about the independent variables in all the 22 projects. I have excluded these projects in analyses were the data are missing, but I have included them in analyses were they have the information that is necessary. This limits my sample size to some extent and there will be variations in how many projects that are included in each analyse.

6.2.1 Cost Target Regression

In this section I have looked at the relationship between cost target and cost gap in order to test hypothesis number 1:

> *There is a negative relationship between conservative cost targets and predicted cost overrun.*

There are 21 projects that are included in this analysis because there was one project that I did not have information about cost target.



Graph 1 Cost target prediction on cost gap

Graph number 1 shows cost target on the horizontal axis and percent cost gap on the vertical axis. The cost target scale ranges from one to three. Number one represents the projects that have a conservative target setting, two represents an average target setting and three represents an aggressive target setting. The vertical axis shows cost gap in percent. 0 % means that there has not been any cost gaps. The projects that have a cost gap over 0 % had a cost overrun. The projects that have a cost gap under 0 % had a cost underrun.

The graph shows an "uphill" slope which ties in with a positive correlation between cost target and cost gap. The graph also shows that the projects that had a conservative target achieved a cost underrun on average and the project that had an aggressive target setting had a cost overrun on average.

These observations indicate that we can predict a cost underrun from the projects that have a conservative target setting. And we can predict a higher average cost overrun from the projects that have an aggressive target setting.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,515489201
R Square	0,265729116
Adjusted R Square	0,22708328
Standard Error	0,174573883
Observations	21

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,20955353	0,209554	6,876009	0,016770091
Residual	19	0,579044772	0,030476		
Total	20	0,788598302			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-0,17949688	0,079681711	-2,25267	0,036295
Cost Target	0,107051197	0,040824729	2,622215	0,01677

Table 4 Cost target prediction on cost gap

By studying the statistical results from table 4, adjusted R-Square is 0, 227. This indicates that cost target explains 23 % of the variance in the cost gap.

The significance value is 0, 0167, hence less than 0, 05 which indicate that the cost target variable is making a unique contribution to the prediction of the overrun. With 98 % of certainty I can be confident that the results obtained are not caused my random factors.

The results from the regression analysis support that conservative cost targets increase the probability of target achievement. This means that a cost overrun could have been avoided by setting conservative targets. Therefore I am able to support hypothesis number

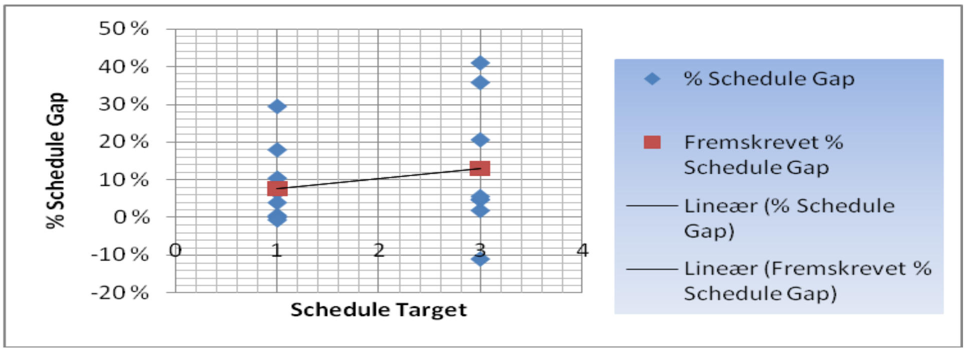
1, that there is a negative relationship between conservative cost target and the predicted cost overrun

6.2.2 Schedule Target Regression

I have looked at the relationship between schedule target and schedule gap in order to test hypothesis number 2:

> *There is a negative relationship between conservative schedule targets and predicted schedule overrun.*

There are 16 projects that are included in this analysis because there was one project I did not have information about schedule target.



Graph 2 Schedule target prediction on schedule gap

Graph number 2 shows schedule target on the horizontal axis and percent schedule gap on the vertical axis. The schedule targets scale are the same as above. Number one represents the projects that have a conservative target setting, two represents an average target setting and three represents an aggressive target setting.

The graph shows a slightly “uphill” slope which ties in with a positive correlation between schedule target and schedule gap. The projects that have a conservative targeting have a slightly lower predicted schedule overrun than the projects that have an aggressive target setting.

These observations indicate that we can predict a lower schedule overrun from the projects that have a conservative target setting. And we can predict a higher average schedule overrun from the projects that have an aggressive target setting.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,388216078
R Square	0,150711723
Adjusted R Square	0,090048275
Standard Error	0,140310707
Observations	16

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,04891	0,04891	2,484391	0,137302769
Residual	14	0,275619	0,019687		
Total	15	0,32453			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-0,027360167	0,074999	-0,36481	0,720708
Schedule Target	0,055726338	0,035355	1,576195	0,137303

Table 5 Schedule target prediction on schedule gap

By studying the statistical results from table 5, the adjusted R-Square is 0, 09. This indicates that the schedule target explains 9 % of the variance in the cost gap.

The significance value is 0, 137. Normally the independent variable has a unique contribution to predict the dependent variable if the significance level is less than 0, 05. In this study I am looking at one predictor that influence the schedule gap, there are other predictors that are influencing the schedule gap as well. Therefore a significance level that shows 0, 1 will be representative.

The significance level in table 5 show a significance level that is close to 0, 1. This indicates that the schedule target is making contribution to the prediction of the schedule gap. However there is a higher uncertainty in these results than if the significance level had been less than 0, 05. The closer the significance level is to zero, the more precise is the estimates. The statistical model had a significance level that showed 0,137 which indicates that I can be 86 % confident that the results obtained are not caused by random factors.

In my research I have chosen a 10% significance level. This means that I have to be 90% confident that the results are not caused by random factors to be able to support the hypothesis.

The results from the analysis support the theory that conservative targets increase the probability of target achievement. The findings indicate that a schedule overrun could have been avoided by setting conservative targets. However the significance level is not high enough to be confident that these findings are not caused by random factors. Therefore I do not have sufficient evidence in my analysis to support hypothesis number 2, that there is a negative relationship between conservative schedule target and the predicted schedule over run.

6.2.3 Target setting predictability on Production Attainment

A question that can be raised from the previous results is; if the conservative targets are too soft and do not challenges the project team, how does this affect project performance? The project reaches their target, like shown in the analysis, but do they achieve lower results than the projects that had an aggressive target setting? Another question can be raised; if aggressive target setting challenges the project team how does this affect project performance? The project do not reach their target, as shown in the analysis, but do they achieve better results than the projects that had a conservative target setting?

To get a clearer understanding of the questions raised above we can look at figure 17.

IPA research shows that when projects with conservative targets are compared with the industry, similar projects are usually performed faster and less expensive. The projects that have aggressive targets have ambition to perform the project faster and to less cost than the industry. A new hypothesis can be developed from these speculations:

There is a positive relationship between aggressive target setting and project performance

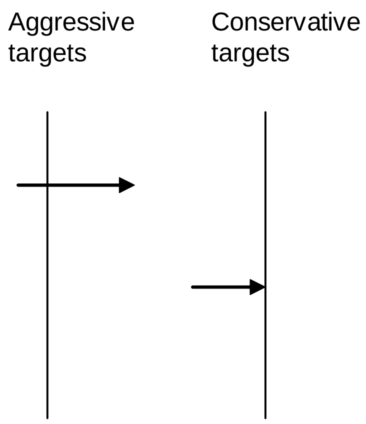
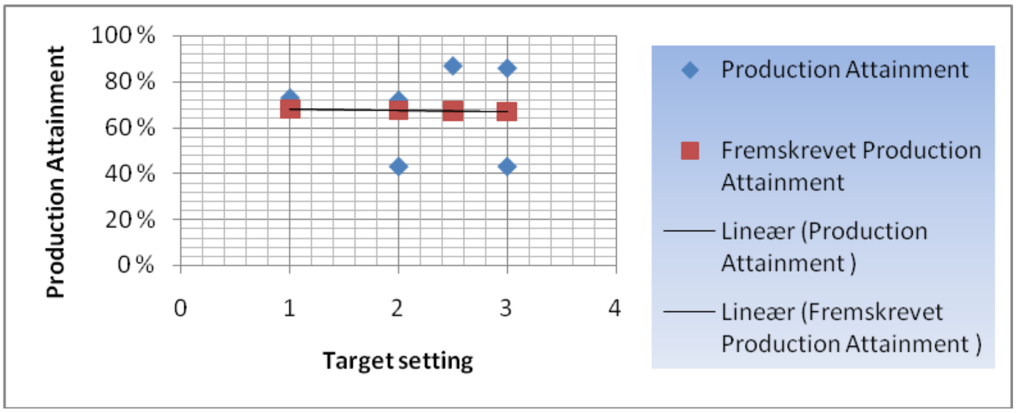


Figure 17 Aggressive targets vs. Conservative targets

Production attainment is the single greatest leveraging element of project performance. An interesting analysis in this area could be to look at the relationship between target setting and production attainment. The objective will be to observe if a project with aggressive target setting achieve a higher production attainment than the projects that have conservative target setting.

I will perform a regression analysis in order to test the hypothesis above. Due to limited data on production attainment there are only 6 projects included in this analysis.



Graph 3 Target setting prediction on production attainment

Graph number 3 shows the mean of cost and schedule targets on the horizontal axis and production attainment on the vertical axis. The target scale is the same as above. Number one represents the projects that have a conservative target setting, two represents an average target setting and three represents an aggressive target setting.

The graph shows a straight line which indicates that there is no relationship between target setting and production attainment. The projects that have a conservative target setting achieve the same production attainment compared to the projects that have an aggressive target setting.

These observations indicate that we can not predict a higher production attainment from the projects that have an aggressive target setting compared to the projects that have a conservative target setting.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,019915
R Square	0,000397
Adjusted R Square	-0,2495
Standard Error	0,222067
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7,83E-05	7,83E-05	0,001587	0,970132013
Residual	4	0,197255	0,049314		
Total	5	0,197333			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,685072	0,308308	2,222036	0,090407
Cost & Schedule target	-0,00522	0,130968	-0,03984	0,970132

Table 6 Target setting prediction on production attainment

By studying the statistical results from table 6, adjusted R-Square is negative. This indicates that target setting does not explain any of the variation in production attainment.

The significance level is 0, 97, which indicates that the target setting does not make unique contribution to production attainment.

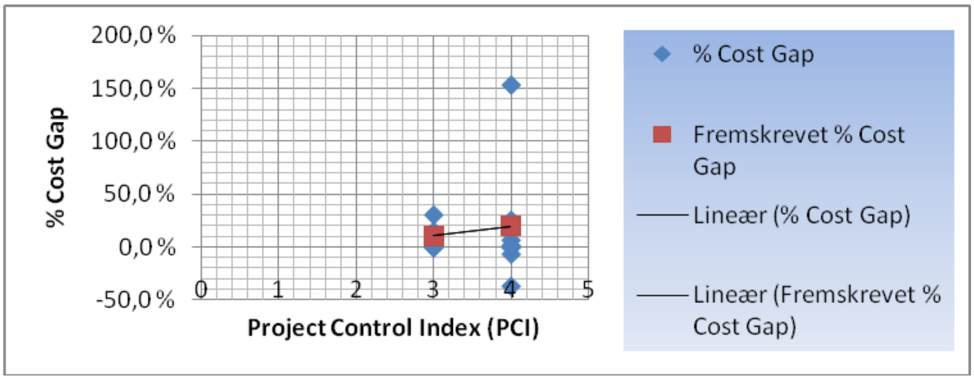
The results from this analysis indicate that the projects could not have achieved a higher production attainment by setting aggressive targets. In other words, the target setting has no influence on production attainment. Therefore I am not able to support the hypothesis, that there is a positive relationship between target setting and project performance when I am looking at production attainment. However the reliability of these results is very low because of the small sample size. More projects have to be included in the analysis and further research has to be done on this area in order to be confident in the results.

6.2.4 Project Control Index (PCI) predictability on Cost Gap

I have looked at the relationship between project control index and cost gap in order to test hypothesis number 3:

> *There is a negative relationship between good project control and predicted cost overrun.*

Due to limited information on project control index, there are only 15 projects that are included in this analysis.



Graph 4 Project control index predictability on cost gap

Graph number 4 shows Project Control Index (PCI) on the horizontal axis and percent cost gap on the vertical axis. The PCI scale ranges from one to four. One represents deficient project control and two represents poor project control. None of the projects included in this sample had deficient or poor project control. Three represents the projects that are rated to have a fair project control and four represents the projects that are rated to have good project control

The graph shows a slightly “uphill” slope which ties in with a positive correlation between project control index and cost gap. In other words the graph shows that the projects with better project control achieves higher cost overrun than the projects that have fair project control.

These results indicate that a cost gap could not be avoided by having good project control. Previous research done in this area shows the opposite; that cost gap can be avoided by having good project control.

A reason for my result can be due to “outliners” – that is, data points that are out on their own, either very high or very low, or away from the main cluster of points. These outliners can seriously influence the analysis, and some statistical texts recommend removing extreme outliners from the data set (Pallant, 2007).

Graph number 4 shows several outliners, and by removing the outliners the graph might show more reliable results.

Before I remove the outliners I will perform a simple bivariate correlation analysis between PCI and cost gap. The objective is to explore the strength and the correlation between the variables.

Correlations

		Cost Gap %t	Project Control Index
Cost Gap %	Pearson Correlation	1	-.303
	Sig. (2-tailed)		.292
	N	21	14
Project Control Index (PCI)	Pearson Correlation	-.303	1
	Sig. (2-tailed)	.292	
	N	14	15

Table 7 Correlation between project control index and cost gap

The results from table 7 show Pearson correlation coefficients (-.303). This indicates that there is a negative correlation between PCI and cost gap. If PCI increases, cost gap will decrease.

One reason for the high correlation between PCI and cost gap could be due to the influence of a third variable: cost target. If cost target influences PCI and cost gap, this could have an impact on the correlation that is obtained in my results. Therefore I have to control the relationship between PCI and cost target.

Correlations

		Project Control Index	Cost Target
Project Control Index	Pearson Correlation	1	-.055
	Sig. (2-tailed)		.847
	N	15	15
Cost Target	Pearson Correlation	-.055	1
	Sig. (2-tailed)	.847	
	N	15	22

Table 8 Correlation between cost target and project control index

Table 8 shows Pearson correlation (-.055). This indicates that there is no correlation between PCI and cost target. The results from table 7 should not have been affected by the cost target variable. A partial correlation analysis will be performed to look at the correlation between PCI and cost gap, this time controlling for, or taking out the effects of cost target.

Correlations

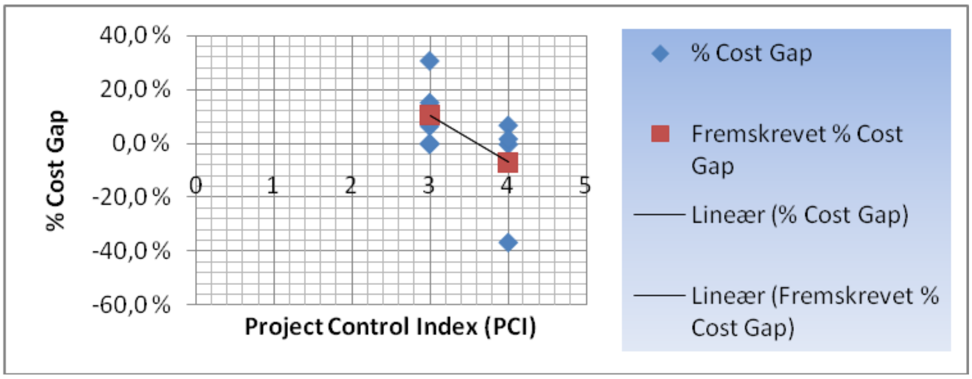
Control Variables			Cost Gap %	Project Control Index
Cost Target	Cost Gap %	Correlation	1.000	-.319
		Significance (2-tailed)	.	.288
		Df	0	11
	Project Control Index	Correlation	-.319	1.000
		Significance (2-tailed)	.288	.
		Df	11	0

Table 9 Correlation between project control index and cost gap, controlling for cost target

Table 9 shows a new correlation (-.319). This indicates that there is a negative correlation between PCI and cost gap after controlling for cost target. The results also indicate that the high correlation between PCI and cost gap is not influenced by cost target.

The results from the correlation analysis confirm my suspicion that the outliners in the simple regression analysis influenced the results that are shown in graph number 4. Therefore I will conduct a new regression analysis were I remove the outliners.

After removing the outliners there are 12 projects that are included in the analysis. The new graph is showed underneath.



Graph 5 Project control index prediction on cost gap

Graph number 5 shows a “downhill” slope which ties in with a negative correlation between PCI and cost gap. The projects that have a fair project control achieve a higher cost overrun compared to the projects that have a good project control.

These observations indicate that we can predict a lower cost over run from the projects that have a good project control, and we can predict a higher cost overrun from the projects that have a fair project control.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,570214397
R Square	0,325144458
Adjusted R Square	0,257658904
Standard Error	0,136350829
Observations	12

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,089573822	0,089574	4,817986	0,052887472
Residual	10	0,185915486	0,018592		
Total	11	0,275489308			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,630331173	0,275607975	2,287057	0,04524
Project Control Index (PCI)	-0,175245612	0,07983887	-2,19499	0,052887

Table 10 Project control index prediction on cost gap

By studying the statistical results from table 10, adjusted R-Square is 0, 2576. This indicates that PCI explains close to 26 % of the variation in the cost gap.

The significance value is 0, 05, which indicates that the project control variable is making a unique contribution to the prediction of the cost gap. With 95 % of certainty I can be confident that the results obtained are not caused my random factors.

The results from the regression analysis indicate the same relationship between PCI and cost gap that was found in the correlation analysis. Graph 5 shows a more realistic relationship between the two variables than graph 4. This indicates that the outliners had a significant impact on my results.

The outcome from the regression and the correlation analyses support that good project control increases the probability of cost achievement, and make it possible for the project team to achieve their cost targets. These findings indicate that a cost overrun could have been avoided by having good project control. From these observations I am able to support hypothesis number 3, that there is a negative relationship between project control and the predicted cost overrun.

Three projects were removed from this analysis because they were outliners. The results changed significantly, and this can affect the reliability of the results.

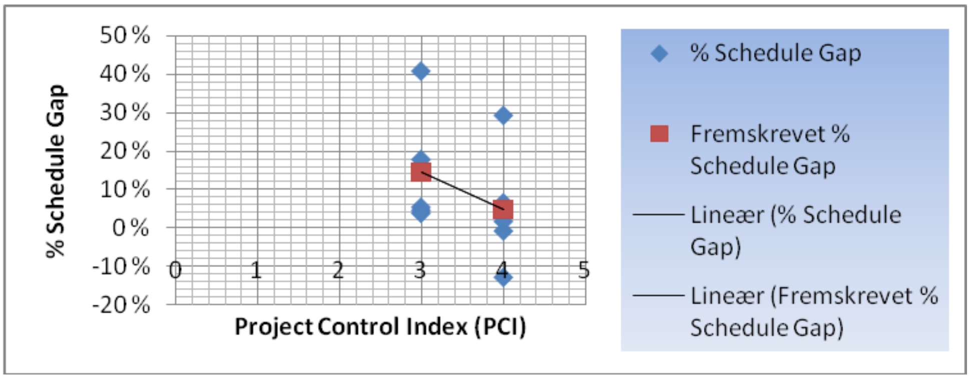
6.2.5 Project Control Index (PCI) predictability on Schedule Gap

I have looked at the relationship between PCI and schedule gap in order to test hypothesis number 4:

> *There is a negative relationship between good project control and predicted schedules slips.*

Due to limited information about PCI and schedule performance there are only10 projects included in this analysis.

Graph number 6 shows the PCI on the horizontal axis, and the percent schedule gap on the vertical axis. The scale is one to four, which represents the same range that is explained above. Number three shows the projects that are rated to have fair project control, and four represents the projects that are rated to have a good project control.



Graph 6 Project control index predictability on schedule gap

The graph shows a "downhill" slope which ties in with a negative correlation between project control index and schedule gap. The projects that have a fair project control index achieves higher schedule overrun than the projects that have a good project control index.

There is one outliner that especially influences the results. Before I remove the outliner, I will perform a simple bivariate correlation analysis between PCI and schedule gap. The objective is to state the strength and the relationship between the two variables.

		Schedule Gap %	Project Control Index
Schedule Gap %	Pearson Correlation	1	-.562
	Sig. (2-tailed)		.115
	N	16	9
Project Control Index	Pearson Correlation	-.562	1
	Sig. (2-tailed)	.115	
	N	9	15

Table 11 Correlation between project control index and schedule gap

The results from table 11 show Pearson correlation coefficients (-.562). This indicates that there is a large negative correlation between PCI and schedule gap. If PCI increases, schedule gap will decrease.

One reason for the high correlation between PCI and cost gap could be due to the influence of a third variable: schedule target. If schedule target influence PCI and schedule gap, this could have an impact on the correlation that is obtained in my results. Therefore a partial correlation analysis will be conducted in order to control that the correlation between PCI and schedule gap is not affected by schedule target.

Correlations

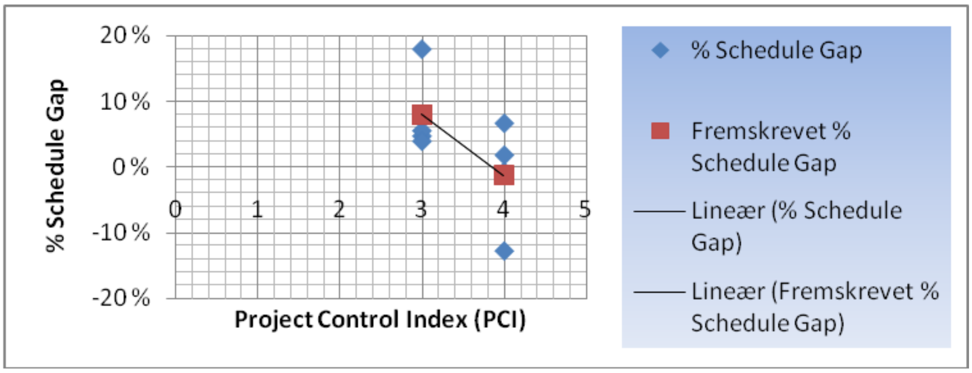
Control Variables			Schedule Gap %	Project Control Index
Schedule Target	Schedule Gap %	Correlation	1.000	-.499
		Significance (2-tailed)	.	.208
		df	0	6
	Project Control Index	Correlation	-.499	1.000
		Significance (2-tailed)	.208	.
		df	6	0

Table 12 Correlation between project control index and schedule gap, controlling for schedule target

The results from table 12 repeats the same set of correlation analysis that is shown in table 11, this time taking out the effects of cost target. Table 12 shows a partial correlation (-.499). The correlation between PCI and schedule gap is slightly reduced when controlling for schedule target. However the negative correlation between the two variables is still strong, which indicates that the high correlation between PCI and schedule gap is not influenced by cost target.

The result, from the correlation analysis confirms my suspicion that the outliner in the simple regression analysis influenced the results that are shown in graph number 6. Therefore I will conduct a new regression analysis were I remove the outliner.

After removing the outliner there are 9 projects that are included in the analysis. The new graph is shown underneath.



Graph 7 Project control index prediction on schedule gap

Graph number 7 shows that the points are closer together and the steepness of the linear line has changed. The standard error is low, which indicates that there is a higher degree of linear relationship between the two variables that can be observed in the graph.

These observations indicate that we can predict a lower schedule slip from the projects that have a good project control compared with the projects that have a fair project control.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,562481045
R Square	0,316384926
Adjusted R Square	0,218725629
Standard Error	0,131241565
Observations	9

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,055801387	0,055801	3,239681	0,114899373
Residual	7	0,120570438	0,017224		
Total	8	0,176371825			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,620829169	0,306386518	2,026294	0,082362
Project Control Index (PCI)	-0,15846332	0,088039518	-1,79991	0,114899

Table 13 Project control index prediction on schedule gap

By studying the statistical results in table 13, adjusted R-Square is 0, 218, which indicates that the PCI explains 22 % of the variation in the schedule gap.

The significance level is 0, 114 which indicates that the project control variable is making a unique contribution to the schedule gap. With 89 % of certainty I can be confident that the results obtained are not caused my random factors. There is a higher uncertainty in these results than if the significance level had been less than 0, 05.

In my research I have chosen a 10% significance level. This means that I have to be 90% confident that the results are not caused by random factors to be able to support the hypothesis.

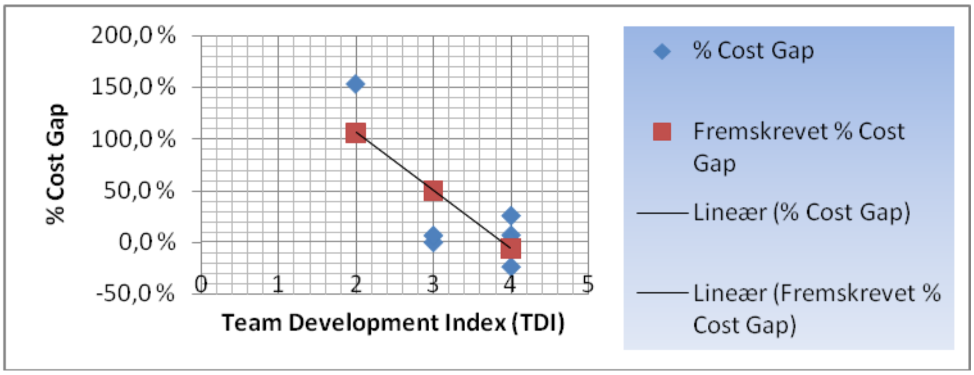
The results from the analysis support that good project control increases the probability of schedule achievement, and make it possible for the project team to achieve their schedule targets. The findings indicate that the schedule overrun could have been avoided by having good project control. However the significance level is not high enough to be confident that these findings are not caused by random factors. Therefore I do not have sufficient evidence in my analysis to support hypothesis number 4, that there is a negative relationship between good project control and predicted schedule slips.

6.2.6 Team Development Index prediction on Cost Gap

I am looking at the relationship between team development index and cost gap in order to test hypothesis number 5:

> *There is a negative relationship between good team development and predicted cost overrun.*

There are 10 projects included in this analysis due to limited information on this area.



Graph 8 Team development index prediction on cost gap

Graph number 8 shows the Team Development Index (TDI) on the horizontal axis and percent cost gap on the vertical axis. TDI ranges from one to four. One represents a deficient team development, two represents a poor team development, three represents a fair team development and four represents a good team development. None of the projects in my sample had a deficient team development.

The graph shows a “downhill” slope which ties in with a negative correlation between TDI and cost gap. The projects that have a poor TDI achieved higher cost overrun than the projects that have a good TDI.

These observations indicate that we can predict a lower cost overrun from the projects that have a good TDI compared with the project that has a poor TDI.

I will perform a simple bivariate correlation analysis between TDI, and cost gap. The objective is to explore the strength and the correlation between the two variables.

The results from table 14 show Pearson correlation coefficients (-.088). This indicates that there is a negative correlation between TDI and cost gap. If PCI increases, cost gap will decrease.

Correlations

		Cost Gap %	Team Development Index
Cost Gap %	Pearson Correlation	1	-.088
	Sig. (2-tailed)		.821
	N	21	9
Team Development Index	Pearson Correlation	-.088	1
	Sig. (2-tailed)	.821	
	N	9	10

Table 14 Correlation between team development index and cost gap

Table 14 shows a very small correlation between the two. One reason for these results could be due to the influence of a third variable: cost target. If cost target influences TDI and cost gap, this could have an impact on the correlation that is obtained in my results. Therefore I have to control the relationship between TDI and cost target.

Correlations

		Team Development Index	Cost Target
Team Development Index	Pearson Correlation	1	.395
	Sig. (2-tailed)		.259
	N	10	10
Cost Target	Pearson Correlation	.395	1
	Sig. (2-tailed)	.259	
	N	10	22

Table 15 Correlation between cost target and team development index

Table 15 show Pearson Correlation (.395). This indicates that there is a positive correlation between cost target and TDI; if cost target increases, TDI will increase. These results can indicate that a team that works well together sets higher targets. Another explanation can be that aggressive targets force the team to work well together in order to achieve their targets. This result indicates that the results from table 14 are affected by the cost target variable.

A partial correlation analysis will be performed to look at the correlation between TDI and cost gap, this time controlling for, or taking out the effects of cost target.

Correlations

Control Variables			Cost Gap %	Team Development Index
Cost Target	Cost Gap %	Correlation	1.000	-.322
		Significance (2-tailed)	.	.437
		Df	0	6
	Team Development Index	Correlation	-.322	1.000
		Significance (2-tailed)	.437	.
		Df	6	0

Table 16 Correlation between team development index and cost gap, controlling for cost target

Table 16 show a correlation on (-.322). This result indicates that there is a negative relationship between TDI and cost gap when I am controlling for cost target. Cost target has a positive affect on team development, and team development has a negative affect on cost gap. This might indicate that a good team sets aggressive targets and this reduces the cost gap. Or it can indicate that aggressive target makes the team perform well and this reduces the cost gap.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,791924289
R Square	0,627144079
Adjusted R Square	0,580537089
Standard Error	0,320689492
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1,383839518	1,38384	13,45601	0,006325495
Residual	8	0,822734001	0,102842		
Total	9	2,206573518			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	2,180311347	0,559642632	3,895899	0,004571
Team Development Index (TDI)	-0,560811003	0,152882717	-3,66824	0,006325

Table 17 Team development index prediction on cost gap

The statistical results in table 17 show that adjusted R-Square is 0, 58, which indicates that TDI explains 58 % of the variation in the cost gap. This result is very high and indicates that TDI is making unique contribution to the prediction of the cost gap.

The significance level is 0, 006, hence less than 0, 05 which indicates that TDI makes a unique contribution to the prediction of the cost gap. With 99 % of certainty I can be confident that the results obtained is not caused my random factors.

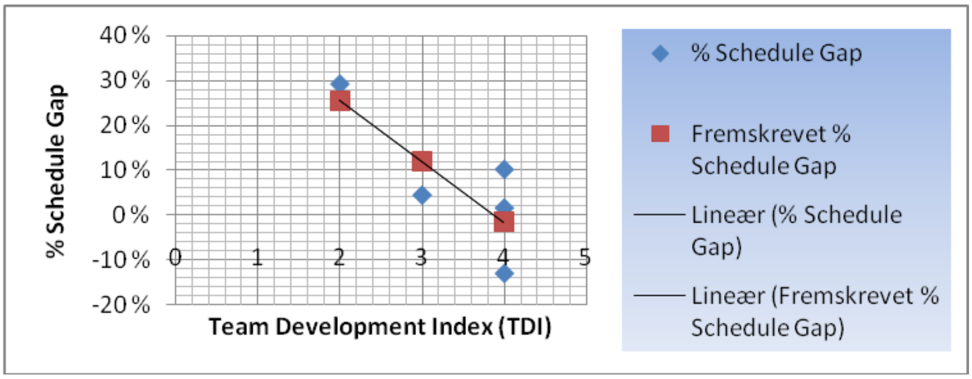
The results from the analysis supports that good team development increases the probability for the project team to achieve their cost targets. These findings indicate that cost overrun could have been avoided by good team development. Therefore I am able to support hypothesis number 5, that there is a negative relationship between good team development and the predicted cost overrun. However there are only 10 projects included in this analysis. More projects have to be included and further research has to be done in order to be confident on these results.

6.2.7 Team Development Index prediction on Schedule Gap

I am looking at the relationship between team development index and schedule gap in order to test hypothesis number 6:

> *There is a negative relationship between good team development and predicted schedule slips.*

There are only 5 projects included in this analysis because of limited information on this area. This affects the reliability of the results.



Graph 9 Team development index prediction on schedule gap

Graph number 9 shows TDI on the horizontal axis and percent schedule gap on the vertical axis. TDI scale ranges from one to four, the same as above. None of the projects had a deficient team development.

The graph shows a "downhill" slope which ties in with a negative correlation between TDI and schedule gap. The projects that have a poor team development index achieve higher schedule overrun than the projects that have a good team development index.

These observations indicate that we can predict a lower schedule slip from the projects that have a good team development compared with the projects that have a poor team development.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,792721552
R Square	0,628407459
Adjusted R Square	0,504543279
Standard Error	0,107730901
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,058881136	0,058881	5,073359	0,109692956
Residual	3	0,034817841	0,011606		
Total	4	0,093698978			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,5277799	0,210351309	2,50904	0,087011
Team Development Index (TDI)	-0,135647909	0,060223405	-2,25241	0,109693

Table 18 Team development index prediction on schedule gap

By studying the statistical results in table 18 adjusted R–Square is 0, 504 which indicates that the team development index explains 50 % of the variance in the schedule gap. This is very high and we can assume that the team development index is making unique contribution to the prediction of the schedule gap.

The significance level is 0, 109, hence higher than 0, 05. The reason for this could be due to the small sample that is included in this analysis. The significance level is close to 0, 1 which indicates that the team development variable is making contribution to the prediction of the schedule gap. However there is a higher uncertainty in these results than if the significance level had been less than 0, 05. The statistical model had a significance level that showed 0,109 which indicates that I can be 89 % confident that the results obtained are not caused by random factors.

In my research I have chosen a 10% significance level. This means that I have to be 90% confident that the results are not caused by random factors to be able to support the hypothesis.

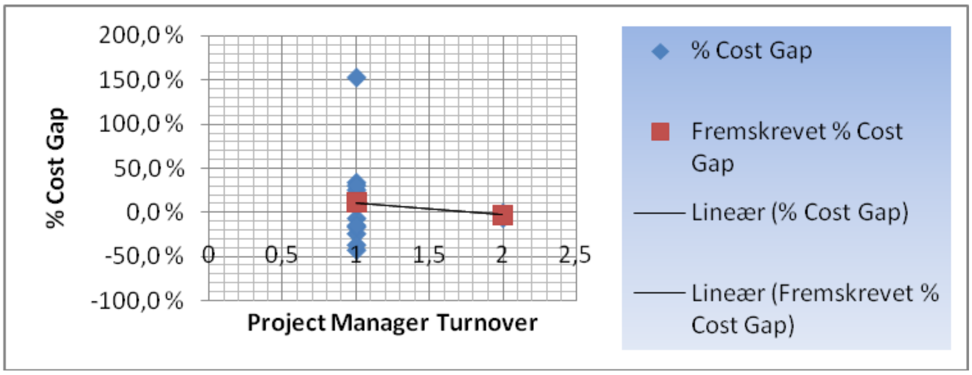
The results form this analysis indicates that good team development increases the probability for the project team to achieve their schedule targets. These findings indicate that schedule overrun could have been avoided by good team development. However the significance level is not high enough to be confident that these findings are not caused by random factors. There are only 5 projects included in this analysis which is not sufficient evidence to support hypothesis number 6, that there is a negative relationship between good team development and predicted schedule slips. More projects have to be included and further research has to be done in order to be confident in these results.

6.2.8 Project Manager Turnover prediction on Cost Gap

I am looking at the relationship between project manager turnover and cost gap in order to test hypothesis number 7:

> *There is a positive relationship between project manager turnover and cost overrun.*

There are 17 projects included in this analysis.



Graph 10 Project manager turnover prediction on Cost Gap

Graph number 10 shows Project Manager Turnover (PMT) on the horizontal axis and percent cost gap on the vertical axis. Number one indicates that there has been project manager turnover during the project period. Number two indicates that there has not been project manager turnover during the project period.

The graph shows a slightly “downhill” slope which ties in with a negative correlation between PMT and cost gap. The projects that experienced PMT achieved a slightly higher cost overrun than the projects that did not experience PMT.

There is one outliner shown in the graph number10 that specifically came to my attention. This outliner could have affected the results. Before I remove the outliner I will perform a simple bivariate correlation analysis between PMT and cost gap. The objective is to explore the strength and the correlation between the variables.

Correlations

		Cost Gap %	Project Manager Turnover
Cost Gap %	Pearson Correlation	1	-.058
	Sig. (2-tailed)		.825
	N	21	17
Project Manager Turnover (PMT)	Pearson Correlation	-.058	1
	Sig. (2-tailed)	.825	
	N	17	18

Table 19 Correlation between project manager turnover and cost gap

The results from table 19 show Pearson correlation coefficients (-.058). This indicates that there is a negative correlation between PMT and cost gap. If PMT increases, cost gap will decrease. A reason for this result could be that StatoilHydro often plan their turnovers in order to increase cost and schedule awareness in the end of their projects. Hence, this could give a negative correlation between PMT and cost gap. However the correlation between the two variables is very small.

One reason for the small correlation between PMT and cost gap could be due to the influence of a third variable: cost target. If cost target influences PMT and cost gap, this could have an impact on the correlation that is obtained in my results. Therefore I have to look at the relationship between PMT and cost target in order to explore the correlation between these two variables.

Correlations

		Project Manager Turnover	Cost Target
Project Manager Turnover (PMT)	Pearson Correlation	1	-.187
	Sig. (2-tailed)		.458
	N	18	18
Cost Target	Pearson Correlation	-.187	1
	Sig. (2-tailed)	.458	
	N	18	22

Table 20 Correlation between cost target and project manager turnover

Table 20 shows Pearson Correlation (-.187). This indicates that there is a negative correlation between PMT and cost target. If PMT increases, cost target decreases. One reason for this result could be that changing project manager is disruptive to projects. It will take time for the new project manager to get settled in a new project and this might lead to inefficient management for a period. This again might affect the cost target.

A partial correlation analysis will be performed to look at the correlation between PMT and cost gap, controlling for cost target.

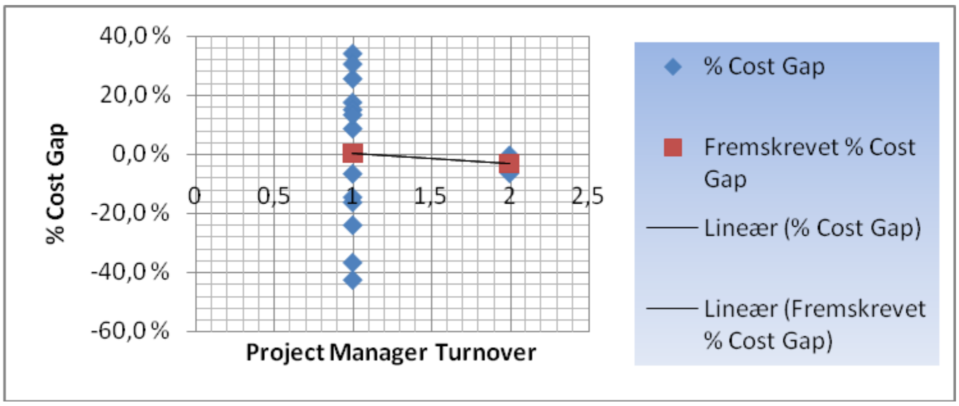
Correlations

Control Variables			Cost Gap %	Project Manager Turnover
Cost Target	Cost Gap %	Correlation	1.000	.086
		Significance (2-tailed)	.	.752
		df	0	14
	Project Manager Turnover (PMT)	Correlation	.086	1.000
		Significance (2-tailed)	.752	.
		df	14	0

Table 21 Correlation between project manager turnover and cost gap, controlling for cost target

The results from table 21 repeats the same set of correlation analysis that is shown in table 19, this time controlling for, or taking out the effects of cost target. Table 21 shows that the new partial correlation is (.086). This indicates that there is a positive correlation between PMT and cost gap after controlling for cost target. If PMT increases, cost gap will increase. However the correlation between the two variables is very small.

After removing the outliner there are 16 projects that are included in the analysis. The new graph is showed underneath.



Graph 11 Project manager turnover prediction on cost gap

Graph number 11 shows that the projects that had project manager turnover are spread widely, they achieved cost overrun and cost underrun. Removing the outliner did not change the graph significantly.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,05833485
R Square	0,00340295
Adjusted R Square	-0,06778255
Standard Error	0,2356496
Observations	16

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0,002654593	0,002655	0,047804	0,830084614
Residual	14	0,777430269	0,055531		
Total	15	0,780084862			

	Coefficients	Standard Error	t Stat	P-value
Intercept	0,03564163	0,188670676	0,188909	0,852875
Project Manager Turnover	-0,03300097	0,150936541	-0,21864	0,830085

Table 22 Project manager turnover prediction on cost gap

By studying the statistical results from table 22, adjusted R-Square is negative. This indicates that PMT does not explain any of the variation in the cost gap.

The significance level is 0, 83, which indicates that PMT is not making unique contribution to the cost gap.

StatoilHydro experience on average a project manager turnover in 70 percent of their projects. These turnovers are often planned for in order to increase cost and schedule awareness in the end of the project. In my sample there are 3 of 17 projects that did not experience turnovers. The three projects that did not experience project manager turnover delivered the projects with a cost underrun. It is hard to indicate if this is a coincident or not because of the small sample size that experienced PMT.

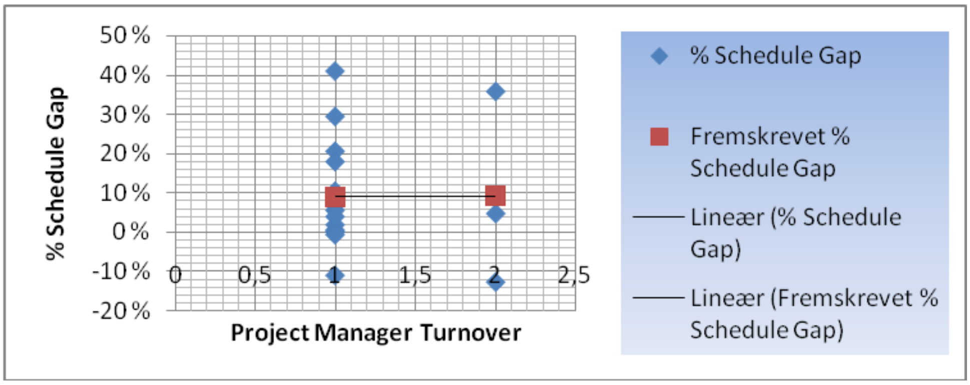
The results from the analysis have a small indication that project manager turnover increases cost gap. However the analysis does not catch the real picture of reality, since there are only three of the projects in my sample that experienced project manager turnover. From these observations I can not support hypothesis number 7, that there is a positive relationship between project manager turnover and cost overrun. More projects have to be included and further research has to be done in order to be confident in these results.

6.2.9 Project Manager Turnover prediction on Schedule Gap

I am looking at the relationship between project manager turnover and schedule gap in order to test hypothesis number 8:

There is a positive relationship between project manager turnover and schedule slip.

There are 17 projects included in this analysis.



Graph 12 Project manager turnover prediction on schedule gap

Graph number 12 shows Project Manager Turnover (PMT) on the horizontal axis and percent schedule gap on the vertical axis. Number one indicates that there has been PMT during the project period. Number two indicated that there has not been PMT during the project period.

The graph shows a straight line which indicates that there are no relationship between PMT and schedule gap. There are no differences in schedule gaps on the projects that had turnovers compared to the projects that did not experience turnovers.

I will perform a simple bivariate correlation analysis between PMT and schedule gap in order to explore the strength and correlation between the variables.

The results from table 23 show Pearson correlation coefficients (.049). This indicates that there is a small positive correlation between PMT and schedule gap. If PMT increases, schedule gap will increase. One reason for the weak correlation between PMT and schedule gap could be due to the influence of a third variable: schedule target. If schedule target influence project manager turnover and schedule gap, this could have an impact on the correlation that is obtained in my results.

Correlations

		Schedule Gap %	Project Manager Turnover
Schedule Gap %	Pearson Correlation	1	.049
	Sig. (2-tailed)		.856
	N	16	16
Project Manager Turnover (PMT)	Pearson Correlation	.049	1
	Sig. (2-tailed)	.856	
	N	16	18

Table 23 Correlation between project manager turnover and schedule gap

I will now look at the relationship between PMT and schedule target in order to explore the relationship between these two variables. The objective is to find out if schedule target influences project manager turnover and schedule gap.

Correlations

		Project Manager Turnover	Schedule Target
Project Manager Turnover (PMT)	Pearson Correlation	1	.255
	Sig. (2-tailed)		.307
	N	18	18
Schedule Target	Pearson Correlation	.255	1
	Sig. (2-tailed)	.307	
	N	18	22

Table 24 Correlation between project manager turnover and schedule target

Table 24 shows Pearson Correlation (.255). This indicates that there is a positive correlation between schedule target and project manager turnover. If schedule target increases, project manager turnover will increase. One reason for this result could be that aggressive schedule target lead to project manager turnover. There is an increased risk associated with aggressive targets. The team and the project manager have to work hard in order to reach their targets. This could be stressful for the project manager and he is responsible if the project do not reach their targets. His reputation and financial compensation is on stake here.

A partial correlation analysis will be performed to look at the correlation between project manager turnover and schedule gap, controlling for schedule target.

Correlations

Control Variables			Schedule Gap %	Project Manager Turnover
Schedule Target	Schedule Gap %	Correlation	1.000	-.041
		Significance (2-tailed)	.	.885
		df	0	13
	Project Manager Turnover (PMT)	Correlation	-.041	1.000
		Significance (2-tailed)	.885	.
		df	13	0

Table 25 Correlation between project manager turnover and schedule gap, controlling for schedule target

The results from table 25 repeats the same set of correlation analysis that is shown in table 23, this time controlling for, or taking out the effects of schedule target. Table 25 shows that the new partial correlation is (-.041). This indicates that there is a negative correlation between project manager turnover and schedule gap after controlling for schedule target. However this correlation is very small.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,006003248
R Square	3,6039E-05
Adjusted R Square	-0,066628225
Standard Error	0,15677244
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1,32868E-05	1,33E-05	0,000541	0,981756626
Residual	15	0,36866397	0,024578		
Total	16	0,368677257			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,087138403	0,123347896	0,706444	0,490741
Project Manager Turnover	0,002319046	0,099740039	0,023251	0,981757

Table 26 Project manager turnover prediction on schedule gap

By studying the statistical results from table 26, adjusted R-Square is negative. This indicates that the project manager turnover does not explain any of the variation in the schedule gap.

The significance level is 0, 98, which indicates that project manager turnover is not making unique contribution to the schedule gap.

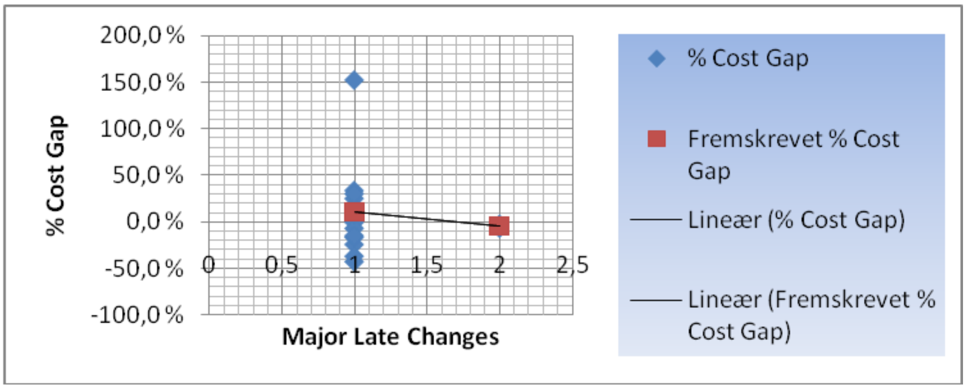
The results from the analysis do not indicate that project manager turnover increases schedule gap. There are only 3 of 17 projects that did not experience turnovers. This might affect the results, because I do not have enough projects with no project manager turnover to explore their prediction on schedule gap. From these observations I can not support hypothesis number 8, that there is a positive relationship between project manager turnover and schedule slips. More projects have to be included in the analysis and further research has to be done in order to be confident in these results.

6.2.10 Major Late Changes prediction on Cost Gap

I am looking at the relationship between major late changes and cost gap in order to test hypothesis number 9:

There is a positive relationship between major late changes and cost over run.

There are 17 projects included in this analysis. There were only 2 of 17 projects that did not have major late changes in my sample.



Graph 13 Major late changes prediction on cost gap

Graph number 13 shows Major Late Changes (MLC) on the horizontal axis and the percent cost gap on the vertical axis. Number one indicates that the project had MLC, while number two indicates that there has not been MLC.

The graph shows a slightly "downhill" slope which ties in with a negative correlation between major late changes and cost gap. The projects that had major late changes had a slightly higher cost over run than the projects that did not have major late changes.

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0,113321496
R Square	0,012841762
Adjusted R Square	-0,052968788
Standard Error	0,443215531
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,038331784	0,038332	0,195132	0,664980751
Residual	15	2,946600103	0,19644		
Total	16	2,984931887			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,251207256	0,388077319	0,647312	0,527213
Major Late Changes	-0,147381627	0,333640531	-0,44174	0,664981

Table 27 Major late changes prediction on cost gap

By studying the statistical results in table 27, the adjusted R-Square is negative. This indicates that MLC do not explain any of the variation in cost gap.

The significance level is 0, 66, which indicates that MLC is not making unique contribution to the cost gap.

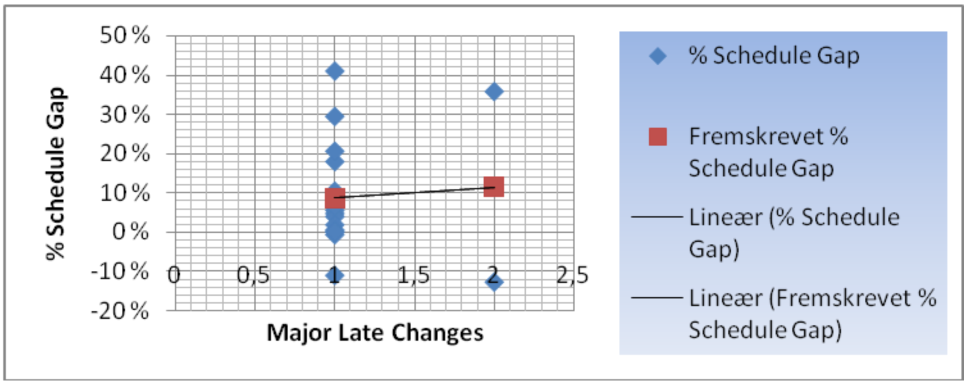
The results from the analysis do not indicate that major late changes increases cost gap. However the analysis does not show reliable results, since there are only 2 of 17 projects in my sample that did not have major late changes. From these observations I can not support hypothesis number 9, that there is a positive relationship between major late changes and cost overrun. More projects have to be included and further research has to be done in order to be confident in these results.

6.2.11 Major Late Change prediction on Schedule Gap

I am looking at the relationship between major late changes and schedule gap in order to test hypothesis number 10:

There is a positive relationship between major late changes and schedule slips.

There are 17 project included in this analysis. There were only 2 of 17 projects that did not have major late changes in my sample.



Graph 14 Major late changes prediction on schedule gap

Graph number 14 shows Major Late Changes (MLC) on the horizontal axis and the percent schedule gap on the vertical axis. Number one indicates that the project had MLC, while number two indicates that there has not been MLC.

The graph shows a slightly "uphill" slope which ties in with a positive correlation between MLC and schedule gap. In other words the graph shows that the projects that did not have major late changes had higher schedule slips than the projects that had major late changes. The reason for this result is that one of the projects that did not experience MLC had a huge schedule gap. This makes a significant impact on the results since there are only 2 of 17 projects that did not experience MLC.

Before I remove the outliner I will perform a simple bivariate correlation analysis between MLC and schedule gap. The objective is to explore the strength and the correlation between these two variables.

Correlations

		Schedule Gap %	Major Late Changes
Schedule Gap %	Pearson Correlation	1	.099
	Sig. (2-tailed)		.715
	N	16	16
Major Late Changes	Pearson Correlation	.099	1
	Sig. (2-tailed)	.715	
	N	16	17

Table 28 Correlation between major late changes and schedule gap

The results from table 28 show Pearson correlation coefficients (.099). This indicates that there is a positive correlation between MLC and schedule gap. If MLC increases, schedule gap will increase.

One reason for the weak correlation between MLC and schedule gap could be due to the influence of a third variable: schedule target. Therefore I am going to look at the relationship between MLC and schedule target in order to explore the relationship between these two variables.

Correlations

		Major Late Changes	Schedule Target
Major Late Changes	Pearson Correlation	1	.065
	Sig. (2-tailed)		.803
	N	17	17
Schedule Target	Pearson Correlation	.065	1
	Sig. (2-tailed)	.803	
	N	17	22

Table 29 Correlation between schedule target and major late changes

Table 29 shows Pearson Correlation (.065). This indicates that there is a positive correlation between schedule target and MLC. If schedule target increases, MLC increases. One reason for this result could be that aggressive schedule target lays a pressure on the project team to work faster. They might have to make fast decisions and this could affect the quality of the work. This could again lead to an increase in major late changes. However the correlation between the two variables is very small.

A partial correlation analysis will be performed to look at the correlation between MLC and schedule gap, controlling for schedule target.

Correlations

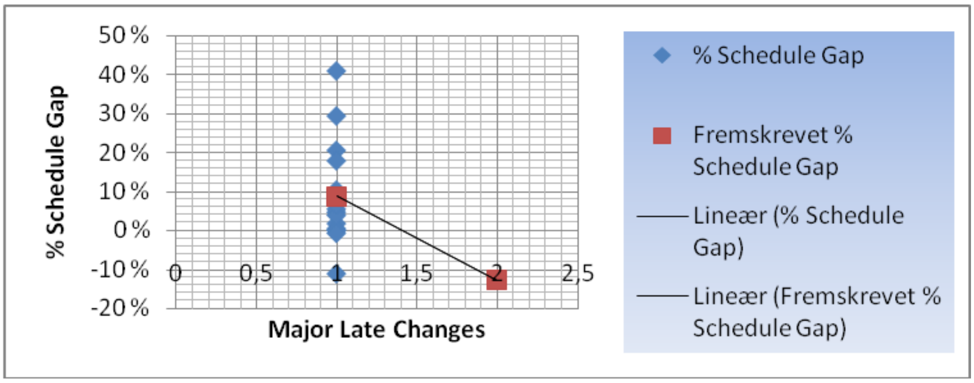
Control Variables			Schedule Gap %	Major Late Changes
Schedule Target	Schedule Gap%	Correlation	1.000	.088
		Significance (2-tailed)	.	.756
		df	0	13
	Major Late Changes	Correlation	.088	1.000
		Significance (2-tailed)	.756	.
		df	13	0

Table 30 Correlation between major late changes and Schedule Gap, controlling for schedule target

The results from table 30 repeats the same set of correlation analysis that is shown in table 28, this time taking out the effects of schedule target. The new partial correlation is (.088). This indicates that there is a positive correlation between MLC and schedule gap after controlling for schedule target.

The result from the correlation analysis confirms my suspicion that the outliners in the simple regression analysis influenced the results that are shown in graph number 14. Therefore I will conduct a new regression analysis were I remove the outliners.

After removing the outliners there are 16 projects that are included in the analysis. The new graph is showed underneath.



Graph 15 Major late changes prediction on schedule gap

Graph number 15 shows a “downhill” slope which ties in with a negative correlation between project MLC and the schedule gap. The projects that have MLC achieve a higher schedule overrun than the projects that did not have MLC.

These observations indicate that we can predict a lower schedule overrun from the projects that did not have major late changes compared with the projects that had major late changes.

The statistical results in table 31 show that adjusted R-Square is 0, 086, which indicates that MLC explains 9 % of the variation in the schedule gap.

The significance level is 0, 141, hence higher than 0, 05. The significance level is close to 0, 1 which indicates that MLC is making contribution to the prediction of the schedule gap. However there is a higher uncertainty in these results than if the significance level had been less than 0, 05. The statistical model had a significance level that showed 0,141 which indicates that I can be 86 % confident that the results obtained are not caused by random factors.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,384357279
R Square	0,147730518
Adjusted R Square	0,086854126
Standard Error	0,13350334
Observations	16

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0,043251939	0,043252	2,426729	0,141594397
Residual	14	0,249523985	0,017823		
Total	15	0,292775924			

	Coefficients	Standard Error	t Stat	P-value
Intercept	0,301377932	0,150253052	2,005802	0,064601
Major Late Changes	-0,21479153	0,137881657	-1,5578	0,141594

Table 31 Major late changes prediction on schedule gap

In my research I have chosen a 10% significance level. This means that I have to be 90% confident that the results are not caused by random factors to be able to support the hypothesis.

The results form this analysis indicates that major late changes increases the probability of a schedule gap. These results are not reliable because there were only 2 of 17 projects in my sample that did not have major late changes. After removing the outliner there was only 1 of the 16 projects that did not have major late changes. Therefore it is possible that the results in my analysis are caused by random factors and I do not have sufficient evidence to support hypothesis number 10, that there is a positive relationship between major late changes and schedule slips.

6.3 Conclusion

Collapse in oil prices together with a high cost level from suppliers, introduces the oil industry to new challenges. The global financial crisis has forced companies to change their priorities, and focus on cost and quality in order to deliver successful projects.

In order to explore the critical success factors that contribute to project success, a qualitative and quantitative research was conducted. Ten hypotheses based on theory and IPA's previous research was formulated. The hypotheses state the relationship between cost and schedule (dependent variables) and the following independent variables: target setting, project control, team development, project manager turnover and major late changes. Then a regression and correlation analysis was conducted in order to explore the relationship between the independent variables and the dependent variables. The data that is presented is based on IPA's reports and grading.

The hypotheses and the results from the regression and correlation analyses are presented below;

Hypothesis 1:

> *There is a negative relationship between conservative cost targets and predicted cost over run.*

These results from my analysis support that conservative cost targets increases the probability of target achievement. These findings indicated that a cost overrun could have been avoided by setting conservative targets. Therefore I was able to support hypothesis number 1.

Hypothesis 2:

> *There is a negative relationship between conservative schedule targets and predicted schedule over run.*

The results from my analysis indicated that a schedule overrun could have been avoided by setting conservative targets. However the significance level was not high enough to be confident that these findings were not caused by random factors. Therefore I did not have sufficient evidence in my analysis to support hypothesis number 2.

From the result of the two previous hypotheses a new hypothesis was developed. The objective was to observe if a project with aggressive target setting achieved a higher production attainment than the projects that had a conservative target setting. The new hypothesis was:

There is a positive relationship between aggressive target setting and project performance

The results from my analysis indicated that target setting did not influence production attainment and I was not able to support the new hypothesis. However the reliability of these results was very low due to limited data on production attainment.

Hypothesis 3:

> *There is a negative relationship between good project control and predicted cost over run.*

The results from the analyses supported that good project control increase the probability of cost achievement. These findings indicated that a cost overrun could have been avoided by having good project control. From these observations I was able to support hypothesis number 3.

Hypothesis 4:

> *There is a negative relationship between good project control and predicted schedules slips.*

The results from the analysis supported that good project control increases the probability of schedule achievement. The findings indicated that the schedule overrun could have been avoided by having good project control. However the significance level was not high enough to be confident that these findings are not caused by random factors. Therefore I did not have sufficient evidence in my analysis to support hypothesis number 4.

Hypothesis 5:

> *There is a negative relationship between good team development and predicted cost over run.*

The result from the analysis supported that good team development increased the probability for the project team to achieve their cost targets. The findings indicated that cost over run could have been avoided by good team development. Therefore I was able to support hypothesis number 5. However there were only 10 projects included in this analysis. More projects have to be included in the analysis and further research has to be done in order to be confident on these results.

Hypothesis 6:

There is a negative relationship between good team development and predicted schedule slips.

The results form this analysis indicated that good team development increased the probability for the project team to achieve their schedule targets. The findings indicate that schedule over run could have been avoided by good team development. However the significance level was not high enough and there were only 5 projects included in this analysis. Therefore I did not have sufficient evidence to support hypothesis number 6.

Hypothesis 7

There is a positive relationship between project manager turnover and cost overrun.

The results from the analysis had a small indication that Project Manager Turnover increased cost gap. However there were only 3 of 17 projects in my sample that experienced Project Manager Turnover. Therefore I did not have sufficient evidence to support hypothesis number 7.

Hypothesis 8

There is a positive relationship between project manager turnover and schedule slip.

The results from the analysis did not indicate that Project Manager Turnover increases schedule slips. There were only 3 of 17 projects that did not experience turnovers. Therefore I was not support hypothesis number 8.

Hypothesis 9

There is a positive relationship between major late changes and cost over run.

The results from the analysis did not indicate that Major Late Changes increases cost gap. There were only 2 of 17 projects in my sample that did not have Major Late Changes. Therefore I was not able to support hypothesis number 9.

Hypothesis 10

There is a positive relationship between major late changes and schedule slips.

The results form this analysis indicated that Major Late Changes increased the probability of a schedule gap. These results were not reliable because there were only 2 of 17 projects in my sample that did not have Major Late Changes. Therefore I did not have sufficient evidence to support hypothesis number 10.

6.4 Limitations of the study & Suggestions for Future Research

During my research I found that IPA's model; *a pathway to success* was rather complex, especially when it comes to Front End Loading (FEL). When IPA is calculating FEL they weight each factor after how important IPA mean they are for the project. Due to the limited time that I had available to do this research I was not able to explore all the nine drivers in the model. Exploring the whole model would be an interesting.

Production attainment is the primary measure of project success. I was not able to get enough data on this area in order to conduct a reliable analyse. This would be an interesting topic for future research.

In my analyse I chose to use a simple linear regression were I am only exploring one independent variable impact on the dependent variable. I was not able to perform a multiple regression analysis because the scale on the different variables was different. With a multiple regression analysis I would have been able to explore all the independent variables impact on the dependent variable.

6.5 Criticism

The research was conducted assuming that all the data in the reports from IPA was correct.

Despite the widespread use of excel and SPSS, there could be bugs within some of the statistical algorithms of the software.

I am only analysing some of the variables that influence project success; there will be other variables that influence project success as well.

I have explored 22 projects, and there are variations in how many projects that are included in each analyse due to limited information. In some of the analysis there was a very small sample included and the results were not reliable. A larger sample is needed to generalize the results and findings from the regression and correlation analysis.

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Appendix A: Project Score Sheet, PDRI

SECTION I - BASIS OF PROJECT DECISION							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
A. MANUFACTURING OBJECTIVES CRITERIA (Maximum Score = 45)							
A1. Reliability Philosophy	0	1	5	9	14	20	
A2. Maintenance Philosophy	0	1	3	5	7	9	
A3. Operating Philosophy	0	1	4	7	12	16	
				CATEGORY A TOTAL			
B. BUSINESS OBJECTIVES (Maximum Score = 213)							
B1. Products	0	1	11	22	33	56	
B2. Market Strategy	0	2	5	10	16	26	
B3. Project Strategy	0	1	5	9	14	23	
B4. Affordability/Feasibility	0	1	3	6	9	16	
B5. Capacities	0	2	11	21	33	55	
B6. Future Expansion Considerations	0	2	3	6	10	17	
B7. Expected Project Life Cycle	0	1	2	3	5	8	
B8. Social Issues	0	1	2	5	7	12	
				CATEGORY B TOTAL			
C. BASIC DATA RESEARCH & DEVELOPMENT (Maximum Score = 94)							
C1. Technology	0	2	10	21	39	54	
C2. Processes	0	2	8	17	28	40	
				CATEGORY C TOTAL			
D. PROJECT SCOPE (Maximum Score = 120)							
D1. Project Objectives Statement	0	2				25	
D2. Project Design Criteria	0	3	6	11	16	22	
D3. Site Characteristics Available vs. Req'd	0	2				29	
D4. Dismantling and Demolition Req'mts	0	2	5	8	12	15	
D5. Lead/Discipline Scope of Work	0	1	4	7	10	13	
D6. Project Schedule	0	2				16	
				CATEGORY D TOTAL			
E. VALUE ENGINEERING (Maximum Score = 27)							
E1. Process Simplification	0	0				8	
E2. Design & Material Alts. Considered/Rejected	0	0				7	
E3. Design For Constructability Analysis	0	0	3	5	8	12	
				CATEGORY E TOTAL			
Section I Maximum Score = 499				SECTION I TOTAL			

SECTION II - FRONT END DEFINITION							
	Definition Level						
CATEGORY Element	0	1	2	3	4	5	Score
F. SITE INFORMATION (Maximum Score = 104)							
F1. Site Location	0	2				32	
F2. Surveys & Soil Tests	0	1	4	7	10	13	
F3. Environmental Assessment	0	2	5	10	15	21	
F4. Permit Requirements	0	1	3	5	9	12	
F5. Utility Sources with Supply Conditions	0	1	4	8	12	18	
F6. Fire Protection & Safety Considerations	0	1	2	4	5	8	
						CATEGORY F TOTAL	
G. PROCESS / MECHANICAL (Maximum Score = 196)							
G1. Process Flow Sheets	0	2	8	17	26	36	
G2. Heat & Material Balances	0	1	5	10	17	23	
G3. Piping & Instrumentation Diagrams (P&ID's)	0	2	8	15	23	31	
G4. Process Safety Management (PSM)	0	1	2	4	6	8	
G5. Utility Flow Diagrams	0	1	3	6	9	12	
G6. Specifications	0	1	4	8	12	17	
G7. Piping System Requirements	0	1	2	4	6	8	
G8. Plot Plan	0	1	4	8	13	17	
G9. Mechanical Equipment List	0	1	4	9	13	18	
G10. Line List	0	1	2	4	6	8	
G11. Tie-in List	0	1	2	3	4	6	
G12. Piping Specialty Items List	0	1	1	2	3	4	
G13. Instrument Index	0	1	2	4	5	8	
						CATEGORY G TOTAL	
H. EQUIPMENT SCOPE (Maximum Score = 33)							
H1. Equipment Status	0	1	4	8	12	16	
H2. Equipment Location Drawings	0	1	2	5	7	10	
H3. Equipment Utility Requirements	0	1	2	3	5	7	
						CATEGORY H TOTAL	
I. CIVIL, STRUCTURAL, & ARCHITECTURAL (Maximum Score = 19)							
I1. Civil/Structural Requirements	0	1	3	6	9	12	
I2. Architectural Requirements	0	1	2	4	5	7	
						CATEGORY I TOTAL	
J. INFRASTRUCTURE (Maximum Score = 25)							
J1. Water Treatment Requirements	0	1	3	5	7	10	
J2. Loading/Unloading/Storage Facilities Req'mts	0	1	3	5	7	10	
J3. Transportation Requirements	0	1				5	
						CATEGORY J TOTAL	
K. INSTRUMENT & ELECTRICAL (Maximum Score = 46)							
K1. Control Philosophy	0	1	3	5	7	10	
K2. Logic Diagrams	0	1				4	
K3. Electrical Area Classifications	0	0	2	4	7	9	
K4. Substation Req'mts Power Sources Ident.	0	1	3	5	7	9	
K5. Electric Single Line Diagrams	0	1	2	4	6	8	
K6. Instrument & Electrical Specifications	0	1	2	3	5	6	
						CATEGORY K TOTAL	
Section II Maximum Score = 423						**SECTION II TOTAL**	

SECTION III - EXECUTION APPROACH							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
L. PROCUREMENT STRATEGY (Maximum Score = 16)							
L1. Identify Long Lead/Critical Equip. & Mat'ls	0	1	2	4	6	8	
L2. Procurement Procedures and Plans	0	0	1	2	4	5	
L3. Procurement Responsibility Matrix	0	0				3	
						CATEGORY L TOTAL	
M. DELIVERABLES (Maximum Score = 9)							
M1. CADD/Model Requirements	0	0	1	1	2	4	
M2. Deliverables Defined	0	0	1	2	3	4	
M3. Distribution Matrix	0	0				1	
						CATEGORY M TOTAL	
N. PROJECT CONTROL (Maximum Score = 17)							
N1. Project Control Requirements	0	0	2	4	6	8	
N2. Project Accounting Requirements	0	0	1	2	2	4	
N3. Risk Analysis	0	1				5	
						CATEGORY N TOTAL	
P. PROJECT EXECUTION PLAN (Maximum Score = 36)							
P1. Owner Approval Requirements	0	0	2	3	5	6	
P2. Engineering/Construction Plan & Approach	0	1	3	5	8	11	
P3. Shut Down/Turn-Around Requirements	0	1				7	
P4. Pre-Commiss. Turnover Sequence Req'mts	0	1	1	2	4	5	
P5. Startup Requirements	0	0	1	2	3	4	
P6. Training Requirements	0	0	1	1	2	3	
						CATEGORY P TOTAL	
Section III Maximum Score = 78						SECTION III TOTAL	

PDRI Total Score

(Maximum Score = 1000)

<u>Definition Levels:</u>

0 = Not Applicable

1 = Complete Definition

2 = Minor Deficiencies

3 = Some Deficiencies

4 = Major Deficiencies

5 = Incomplete or Poor Definition

Appendix B: Front End Loading Categories & Elements

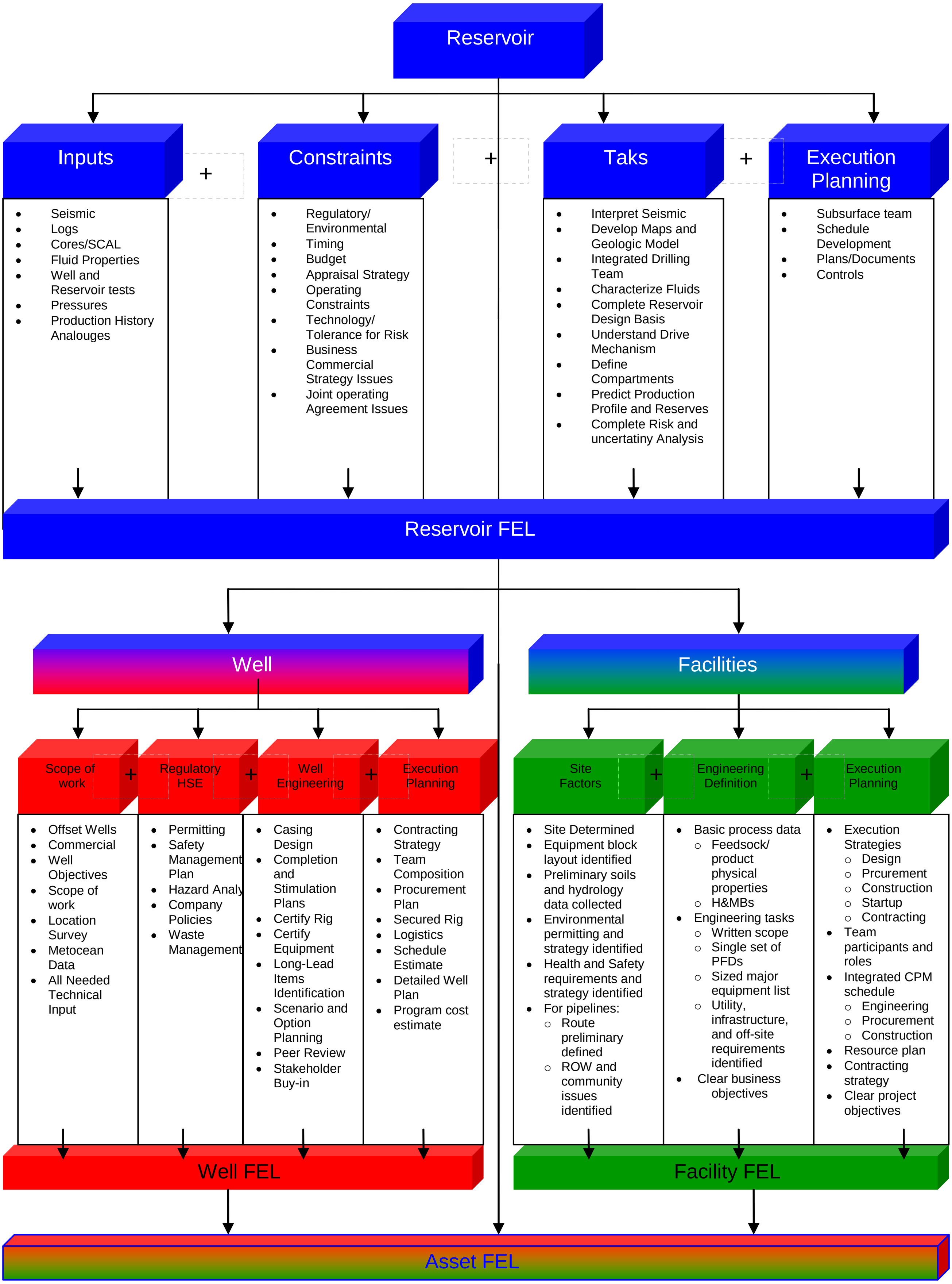

Figure 18 Front End Loading Categories & Elements adapted from (IPA)

Appendix C: Value Improving Practices

- **Technology Review and Selection**. A formal, multidisciplinary team process that searches and screens alternative technologies to identify opportunities that may yield a significant competitive advantage. This process involves both internal and external reviews of reservoir, drilling, completion and facilities technology that may range from research concepts to emerging or fully proven technology.

- **Flow Assurance & Reliability Modeling**. A methodology intended to increase value by providing an objective analysis of the production reliability, capacity alignment, and uncertainties surrounding the production stream. The relationships of all components in the system are analyzed beginning with the static reservoir pressure through to the separator.

- **Process Simplification**. A disciplined analytical method for reducing investment costs—and often operating costs as well—by either combining or making unnecessary one or more chemical or physical processing steps.

- **Predictive Maintenance**. An approach to maintaining a facility whereby equipment is monitored and repairs are made before failure. Typically, this approach requires adding various measurement devices to evaluate operating characteristics.

- **Customized Standards and Specifications**. An evaluation of the needs of a specific facility before it is designed. Engineering standards and specifications can affect manufacturing efficiency, product quality, operating costs, and employee safety. However, the application of codes, standards, and specifications sometimes exceeds the facility's needs and unnecessarily increases cost.

- **Design-to-Capacity.** An evaluation of the maximum capacity of each major piece of equipment. Often equipment is designed with a "safety factor" to enable catch-up capacity to be added if production needs to be increased.

- **Classes of Facility Quality**. An analysis that establishes the necessary quality of the facility to meet business goals. This VIP evaluates reliability, expandability, use of automation, life of the facility, expected stream factor, likelihood of expansion, production rate changes with time, product quality, and product flexibility. The Classes of Facility Quality VIP can be used to determine needed design allowances, redundancy, sparing philosophy, and room for expansion.

- **Value Engineering.** A disciplined method used during design, requiring the use of a trained Value Engineering consultant—usually from outside the project team—aimed at eliminating or modifying items that do not contribute to meeting business needs.

- **Constructability Reviews.** An analysis of the design, usually performed by experienced construction managers, to reduce costs or save time during the construction phase. To be considered a VIP rather than just a good project practice, Constructability Reviews must begin during FEL and be repeated through construction.

- **Energy Optimization.** A simulation methodology for optimizing the life cycle costs by examining power and heating requirements for a particular process. The objective is to maximize the total return by selecting the most economical methods of heat and power recovery.

- **Waste Minimization** A disciplined approach used during design to minimize the production of waste products. This VIP might result in the addition of equipment or examination of alternate process technologies that have a lower amount of waste sidestreams.

- **3D CAD** The use of three-dimensional computer-aided design (3D CAD) during Front-End Loading and detailed engineering. The objective is to generate computer models of the project to reduce the frequency of dimensional errors and spatial conflicts that create the need for design changes during construction. The use of 3D CAD also improves visualization of the facility, which increases the quality of Operations' input and training. To be considered a VIP rather than just a good project practice, 3D CAD must be used during FEL as well as detailed engineering.

- **Risk and Uncertainty Analysis (RUA).** A formal structured process following standardized procedures, often facilitated at strategic points. The process should quantify the impact of risk and uncertainty on business objectives and provide a plan to mitigate against the identified risks and uncertainties. To ensure consistency, the process must incorporate experts outside the team versed in risk assessment and technical uncertainties. The decision to use internal versus external technical resources depends on the size and complexity of the project.

- **Full Cycle Depletion Plan**. A plan for producing Norsk Hydrocarbons through the full life of the field, from present to abandonment. The development plan (number of wells, resource promise, production, cost and benefits, etc.) and alternatives reviewed are qualified and documented. An important element is the information collection on which management decisions depend. The analysis involves assigning risks and integrating reservoir, wells, processing facilities, export, health, safety, and environmental management.

- **Well Definition and Design.** A systematic set of activities led by a facilitator to clearly define development wells in a way that is aligned with the company's strategic business objectives and depletion plan. This practice should establish the optimal technical basis of well and completion design. It employs reservoir characterization and other relevant subsurface data in conjunction with safety, health and environmental effects, development concept, expected asset life, applicable regulations and standards, and operation environment.

- **3D Visualization** A practice in which all subsurface groups, Geology and Geophysics, Reservoir Engineering, and Drilling and Completions, share a 3D earth model and interpretation. The shared earth model is used to perform geologic evaluation of the reservoir and field, 3D simulation of the reservoir, depletion planning, and well bore planning. An interactive visualization center may be used to enhance this process, but is not essential. The Value Improving Practices is divided in applicable and not applicable for each project. The project gets a grade depending on how many VIPs that is planned to be used during the project.

(IPA, 2008)