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Methodology for Project Evaluation

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Abstract

Recent studies reveal that the offshore projects undertaken on the Norwegian Continental Shelf failed consistently to deliver on time and budget. The study performed by Norwegian Petroleum Directorate (NPD) confirms major cost & schedule overruns.

It was identified that numerous International oil and gas projects faced similar challenges in meeting the budgets and schedule. In spite of having various project management techniques, the oil companies (operators) still experience challenges to track the project deliverables.

With the current lower oil prices, executing projects on time (OTD-On Time Delivery) according to the agreed budget is the need of the hour for the Norwegian oil and gas industry.

This thesis looks into developing a methodology to track the projects and handles various project issues early so as to manage effective project deliveries.

This study identifies various key issues that have promoted project failures in different project phases on an EPCIC project model. This thesis shows how to effectively capture the project issues and enhance overall project performance.

This thesis covers various critical parameters that need to be managed in various phases of the EPCIC project. This thesis thus proposes a project evaluation methodology through using a “stage gate” criteria and also proposes a project model that could effectively manage the projects.

Acknowledgments

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Abbreviations

ISO	International Organization for Standardization
DNV	Det Norske Veritas
PSA	Petroleum Safety Authority Norway
NPD	Norwegian Petroleum Directorate
MPE	Ministry of Petroleum and Energy
PDO	Plan for Development and Operation
PIO	Permits for Installation and Operation
EPCIC	Engineering, Procurement, Construction, Installation, Commissioning & Hook-Up
NMA	Norwegian Maritime Authority
DSB	Norwegian Directorate for Civil Protection
NCS	Norwegian Continental shelf
NOFO	Norsk Oljevernforening for Operatørselskap
API	American Petroleum Institute
TR	Technical Regulations
CAPEX	Capital Expenditure
OPEX	Operating Expenditure
FEED	Front End engineering Design
HSE	Health, Safety, Environment
HAZOP	Hazard and Operability study
HAZAN	Hazard Analysis
PRINCE	Projects IN Controlled Environments
PMI	Project Management Institute
ASAPM	American Society for the Advancement of Project Management
APM	Association for Project Management
CIAM	Cluster on Industrial Asset Management
PEM	Project Engineering and Management
FPSO	Floating Production Storage Offloading
KISOLL	Knowledge Investment Strategies on Local Level

Chapter 1 Introduction

1.1 Background

Cluster on Industrial Asset Management (CIAM) – Project Engineering and Management (PEM) Hub is currently working on a project called "Cross Functional Excellence in Project Management" and this thesis is undertaken as a part of the CIAM Hub Project.

A unique endeavor which is undertaken to achieve a desired outcome is termed as a project (Project Management, 2000). Achieving the defined goals and objectives within the specified constraints of schedule and budget that leads to customer satisfaction define the success of a project (Project Management, 2000).

Recent studies reveal that major projects within industry sectors (transport, defense, aeronautical, ship building etc.) frequently experience considerable cost overruns and delays. According to the survey made Standish group for IT projects (spanning an investment of USD 250 billion) it was found that only 19% were cancelled before they'd completed, 35% were delivered on-time/on-budget, 60% ran over the budget/schedule (Oakes & Oakes, 2012)

Projects in aviation, royal navy, construction and oil industry involve multimillion to multibillion dollars investments. These huge projects demand the need for efficient project monitoring techniques to decrease the downtime and increase the yields. EADS (European Aeronautic Defense and Space Company) alias Airbus group had experienced a cost overrun of $2billion for the delivery delay of the military transport plane A400M (Clark, 2014).

Currently Norwegian Oil Industry is going through a recession phase due to the lower oil prices and this pushes for the need for On Time Delivery (OTD) of the projects. The dramatic fall in oil prices has rapidly changed the entire industry's focus to enhance efficiency and cost saving. Today, large projects in the oil and gas industry face many challenges since they have become increasingly complex and technologically demanding (Agbo). On-time deliveries (schedule), on budget deliveries (costs), safety, environmental issues etc. are some of the challenges faced by Norwegian oil industry.

The study performed by renowned Project Analyst, Ed Merrow reveals that the petroleum industry suffers heavily at delivering projects on budget and on time (Merrow, 2012). The report from Independent Project Analysis (IPA) made by Mishra also reveals that projects undertaken on the Norwegian continental shelf (NCS) perform worse when compared to projects in the Gulf of Mexico (GoM) region.

Historical cases have numerical examples where projects couldn't meet their commitments. Thus we need to have an efficient methodology to closely monitor the project, capture various issues very early thereby delivering projects effectively.

1.2 Statement of the Problem

The last 14 years, Norwegian oil and gas projects exceeded the budget slams with over 200 billion. A review of all state budgets since 2002 till 2015 show that the total overruns is around 200.978 billion kroner. That is almost 201 billion (Taraldsen, 2015).

ENI Goliath project is a classic example of recently overrun project (from a planned budget of 30 billion NOK to a final price of 47 billion NOK). Martin Linge project has been over 7 billion more expensive than initially anticipated.

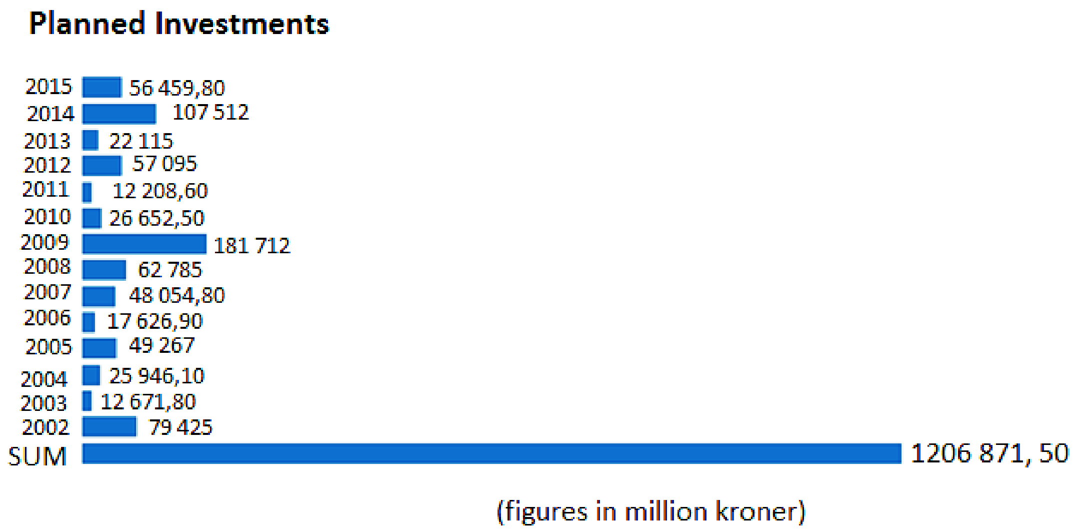


Figure 1: Planned Investments on NCS (Taraldsen, 2015)

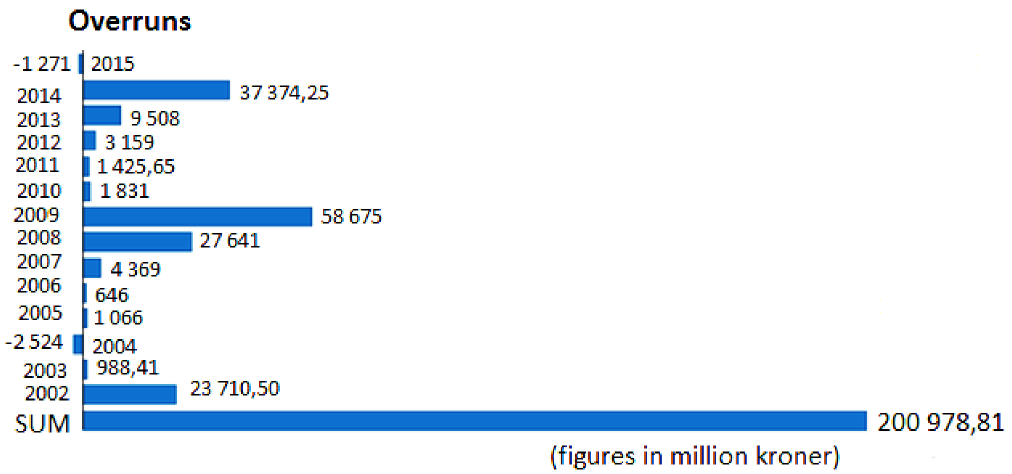


Figure 2: Overruns on NCS (Taraldsen, 2015)

Inspite of having some existing guidelines on how to manage Projects such as Project Management Institute (PMI), American Society for the Advancement of Project Management (ASAPM), Association for Project Management (APM) etc., we see that many projects struggle with issues regarding budgets, schedules & execution.

Thus we see the need to look into the whole project lifecycle in the following:

- Objectives: appropriate and realistic objectives
- Stakeholders: common understanding, objectives, well defined responsibilities
- Processes: appropriate processes, needs to be monitored
- Performance: Need to understand how the teams, tools and suppliers are actually performing to meet the desired goals/objectives.

Project reviews and assurance help people to really understand what's really going on with their projects.

1.3 Objective of the thesis

The objective of this thesis is to develop a "Project Evaluation Template" applicable for the Oil & Gas Industry that shall capture potential issues in different project phases and ensure overall project success. This is achieved through a detailed literature review and through a detail study of numerous failed projects on the NCS as well as other International Projects to analyze the root causes that instigate the project delays. This thesis proposes a PRINCE2 - Project Execution model that drives the project in the correct direction through controlling & escalating issues to higher level for effective decision making.

The " Project Evaluation Template" developed above is then applied to a typically failed Offshore North Sea Project to see if the template developed effectively captures the project issues very early thereby minimizing the project failure.

1.4 Methodology

Cluster on Industrial Asset Management (CIAM) – Project Engineering and Management (PEM) Hub is currently working on a project called "Cross Functional Excellence in Project Management". The Hub team members are developing a project evaluation template using an existing old project evaluation template developed for KISOLL (Knowledge Investment Strategies on Local Level) European Union Project and through a series of brain storming sessions/discussion meetings.

All heavy industries do have an EPCIC model (EPCIC- Engineering, Procurement, Construction, Installation, Commissioning & Hook-Up) for project execution. For the purpose of the thesis we shall look at this EPCIC model which is widely used model in Oil & Gas Industry. These EPCIC model can be suited to other industries as well.

In early 1990's on the NCS , the oil companies (the license and the operators) coordinated deliveries from several sub-contractors those specialized in domains such as project management, engineering, module fabrication, offshore/onshore hook-up or marine operations. Today, the Norwegian offshore development market is dominated by three to four major entities (from concept development to offshore installation and start up). The project management tasks that were earlier carried out by a project team managed by the client, were now itself managed by the major offshore contractors i.e., EPCI-contracts, Engineering, Procurement, Construction, Installation (Emhjellen, Emhjellen, Osmundsen, & Gassmarkeder, 2001).

In this thesis the old project evaluation template developed for KISOLL EU Project is refined to tailor it to the Oil & Gas Industry.

The project phases in the KISOLL EU Project are refined to suit the EPCIC model lifecycle phases. Thus project lifecycle is divided into different phases namely Feasibility /Concept / FEED phase, Engineering phase, Procurement Phase, Construction Phase, Installation Phase, Hookup & Commissioning phase, Project Closure Phase.

Then the evaluation parameters described in the KISOLL EU Project are then refined to reflect the critical evaluation parameters that determine the project success in each project phase defined above. These are identified from the literature review and through the study of failed offshore projects.

Then Critical Parameters needs across each phases are then listed in the template.

Stage GATES are introduced while moving from one phase to the next phase. Stage GATES encompasses as series of hold points & check points which helps in identifying project deliverables at the end of the stages which thereby promote the overall the project success. These are identified from the literature review and through the study of failed offshore projects. The proposed PRINCE2 (Projects IN Controlled Environments) Project Execution Model helps in driving the project in the correct direction through controlling & escalating issues to higher level for effective decision making.

Based on the importance of the critical parameters in each project phases, these parameters are rated from a scale of 1 to 5.

Also at the end of completion of each Stage, the completed phases are ranked from a scale of A to E. Minimum Phase Rank needed to proceed to the next phase is then defined at this Stage.

The critical rated parameters are visualized in each phase through bar chart. The developed template can be used for other heavy industries as well.

1.5 Limitations of the Study

In an EPCIC model the whole project deliverables are divided into a number of work packages. There might be only few work packages that might have promoted to project failure while other work packages might have been delivered in accordance to the plan.

Thus while analyzing the failed offshore Project using the newly developed "Project Evaluation template" the analysis is restricted to a specific work package that had contributed to the project failure. The plugging & abandonment phase in a typical offshore field life cycle is not considered while developing "Project Evaluation template" for the EPCIC Project model. The information needed to develop the template is derived using the publicly available data for the offshore failed NCS projects since there was no access to the confidential material data

1.6. Thesis Structure

This thesis is presented in 7 chapters.

Chapter 1 provides the Background for the Study, Description of the Problem, Objectives of the thesis, Methodology used to develop the template & Limitations of the study.

Chapter 2 presents a review of existing literature relevant to the thesis topic and identifies the focus area of the study.

Chapter 3 studies various International and Norwegian Continental Shelf offshore failure projects.

Chapter 4 provides the methodology for the development of project template

Chapter 5 presents application of the project template to a failed offshore project

Chapter 6 discusses the results of the analysis and provides conclusion

Chapter 7 discusses suggestions for future study

Chapter 2 Literature Review

Project: A project is "a temporary effort undertaken to create a unique product or service" (Project Management, 2000)

2.1 Project Life Cycle

Life Cycle Phases: According to Project Management Institute, project life cycle comprises the following phases as shown in Figure 1(Project Management, 2000):

- **Project Initiation**: This is the first phase of the project where business problem is identified, business case (various solutions options) defined and a final recommended solution is put forward. Then a project charter (outlines the objectives, scope of the project), project team is established and approval is sought to move to the next detail planning phase. Thus this phase comprises of initiation, identification, selection concept definition, project charter (Westland, 2006).

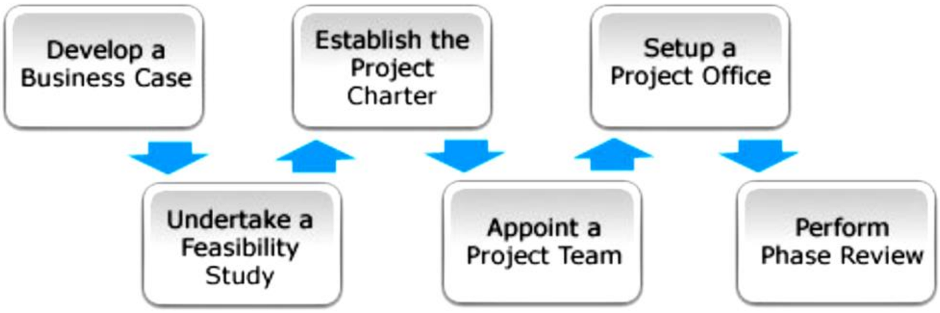


Figure 3: Project Initiation Phase (Westland, 2006)

- **Project Planning** : This detailed planning phase involves creation of Project plan (defines tasks or activities and timeframe to achieve these), Resource plan (defines the materials , equipment and labor required), financial plan (identifying labor, equipment and material costs), quality plan (defining quality specifications, assurance and control measures), Risk plan (potential risks are highlighted and mitigating actions charted out), acceptance plan (criteria to gain acceptance), communication plan (defines information for stakeholders/licensees), procurement plan (defines products/services to be sourced from vendors etc.). Thus this phase comprises of definition, feasibility confirmation, development, demonstration, design prototype, quantification etc. (Westland, 2006)

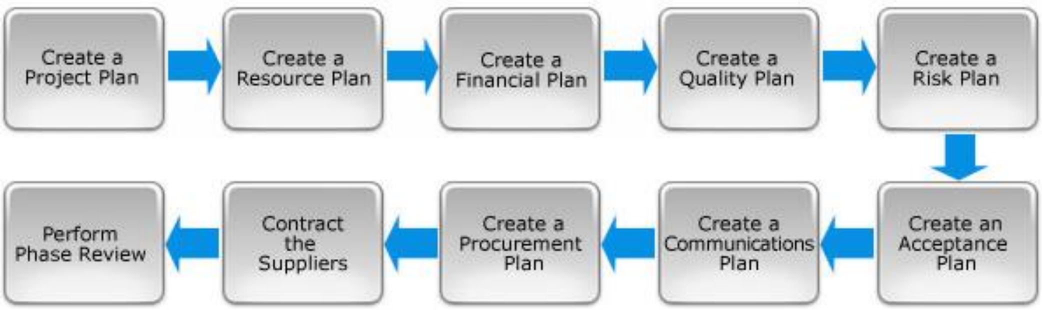


Figure 4: Project Planning phase (Westland, 2006)

- **Execution phase**: It involves execution of the activities as per the plans defined in stages above using management processes to monitor and control the project deliverables. This is achieved using change management process, risk management process, acceptance criteria etc. The project will be ready for closure once the deliverables are achieved and customer acceptance is obtained. This phase thus highlights execution, implementation, design/construct/ commission, installation and test

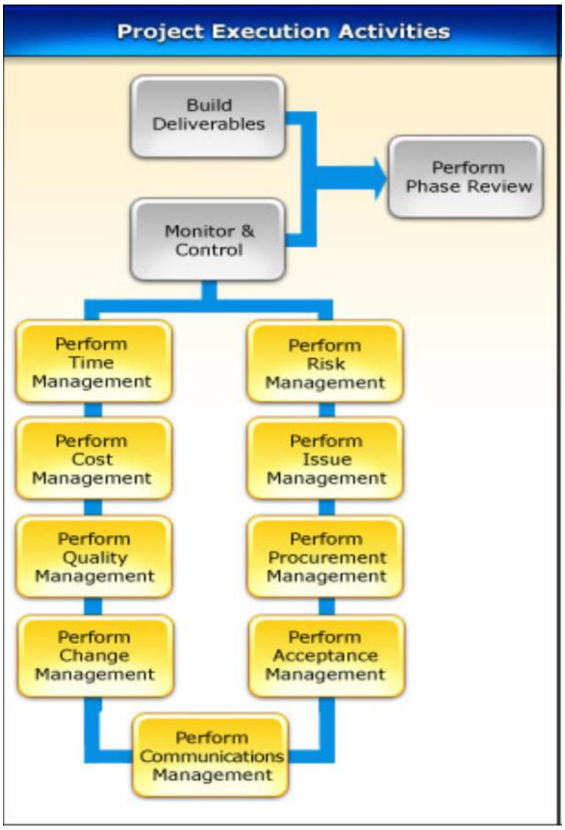


Figure 5: Project Execution Phase (Westland, 2006)

- **Project Close out**: This includes handling over deliverables (products/services etc.) to end customer, documentation, terminating supplier contacts, closing billing milestones, communicating project closure to stakeholders & often includes post-completion evaluation. (Westland, 2006)

Figure 6: Project Close Out Phase(Westland, 2006)

The Figure given below gives a clear picture of the project life cycle.

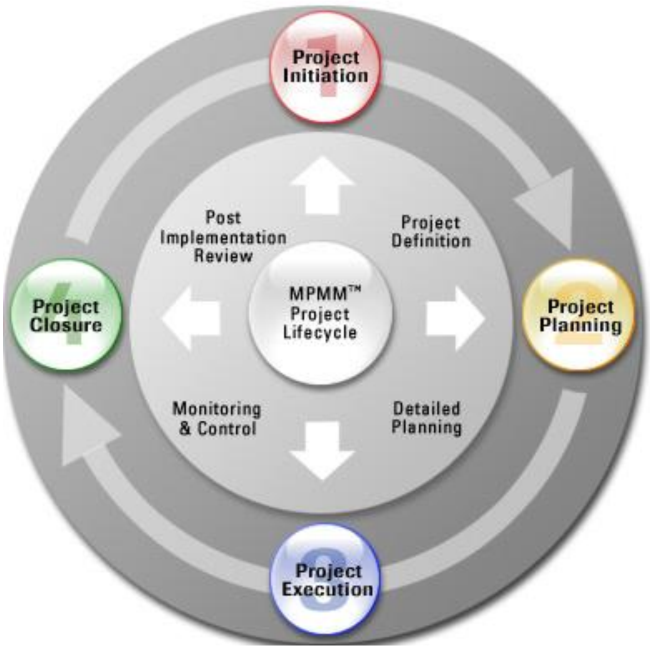


Figure 7: Project Life Cycle (Westland, 2006)

The above project phases Project Starting, Project Planning, Projection Execution for a typical oil field development project is shown below:

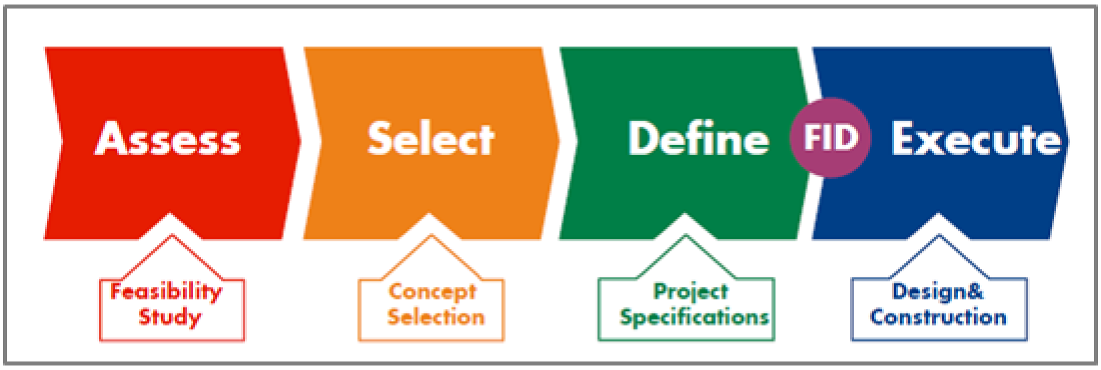


Figure 8: Project Phases in Oil Field development (Barton, 2015)

Feasibility study: This stage comprises of performing feasibility study, alternate(s) identification, screening studies, methodology identification, assessment of schedule and costs etc.

Concept Selection: This involves Concept selection, Flow schematics, Selection of codes and standards, assessment of environmental/social consequences, Risk assessments & Project costs estimates and overall economics

Project definition: This stage includes FEED (Front-end engineering design), PBD (Project basis of design), process / hydraulic/multiphase flow analysis, Initial utility flow / PID's, HAZOP & HAZID reviews, EIA (Environmental impact assessments), HSE etc.

Execution Stage: This stage is defined by detailed design, Final process/ utility flow diagrams, Final PID, cross functional engineering collaboration (mechanical, civil, piping, ICT, electrical etc.), Procurement equipment packages, Third party review etc.

Typical Life Cycle Phases and Lifecycle models:

Life cycle Phases:

According to Project Management Institute, the four generic Project Phases in any industry are shown below (Project Management, 2000):

Figure 9: Typical standard top level project life cycle model (Archibald, Filippo, & Filippo, 2012)

Critical decisions such as proceed, cancel, revise scope/cost/schedule are studied before proceeding to the next phase.

Figure 10: Six-phase comprehensive top level project life cycle model (Archibald et al., 2012)

The two phases added above to standard project lifecycle model were

1. Project Incubation/Feasibility Phase:

Incubation/Feasibility phase helps in understanding the principal objectives, scope, schedule, and cost of the project. Project success factors such governmental authority's approvals or other approval agencies (such as environmental, economic, health etc.) are identified in this phase. Also the overall economic hurdles, technological challenges, political challenges, risks etc. are identified in this phase.

2. Post-Project Evaluation Phase:

In this phase three main dimensions are analyzed for measuring project success

Project Management dimension: The project is analyzed to understand if it achieved the original objectives (as defined in the business case), looks if the end product have met the laid specifications and is within the budget, schedule etc.

Product Dimension: Measures product against KPI (Key Performance indicators)

Stakeholder Dimension: Level of satisfaction among project stakeholders is analyzed.

Typical Project Lifecycle models:

The figures below gives some overall picture of typical project lifecycle models in various industries.

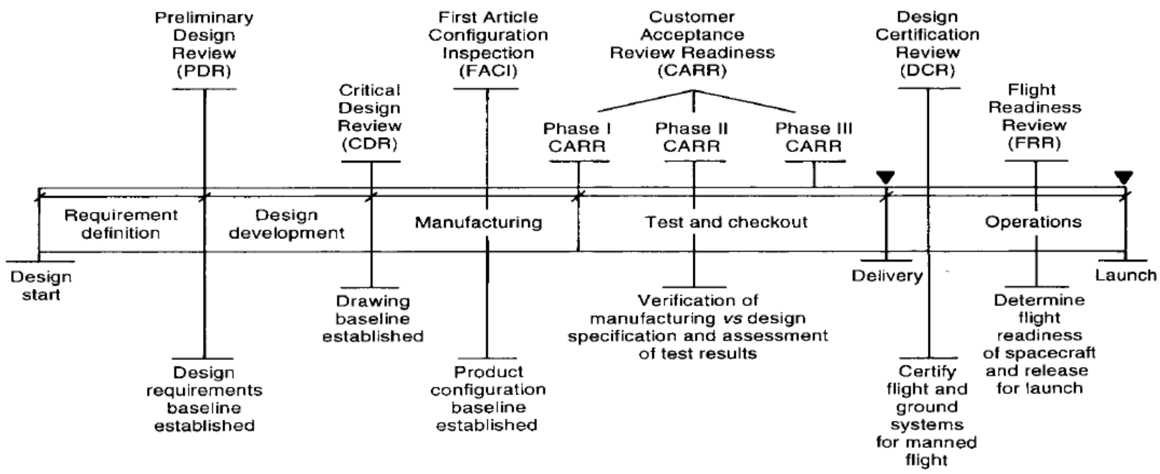


Figure 11: Simplified version of NASA's Project Life Cycle Process (Archibald et al., 2012)

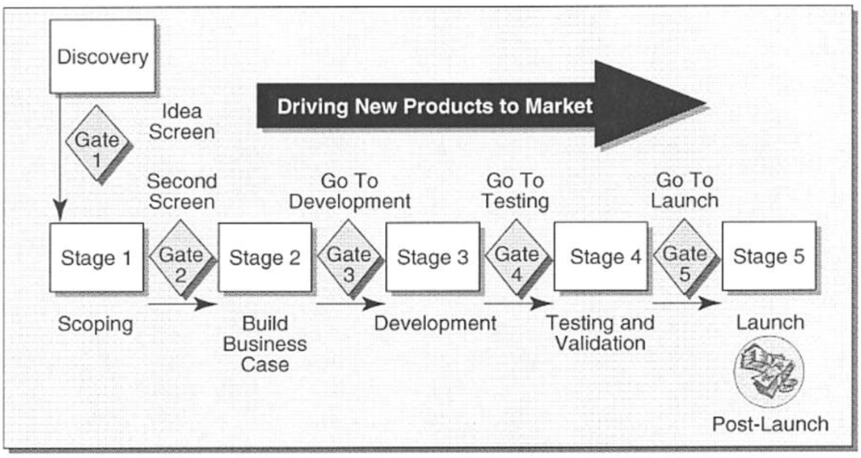


Figure 12: Overview of a typical Stage-Gate project life cycle process for new product development (Cooper, Edgett, & Kleinschmidt, 2001)

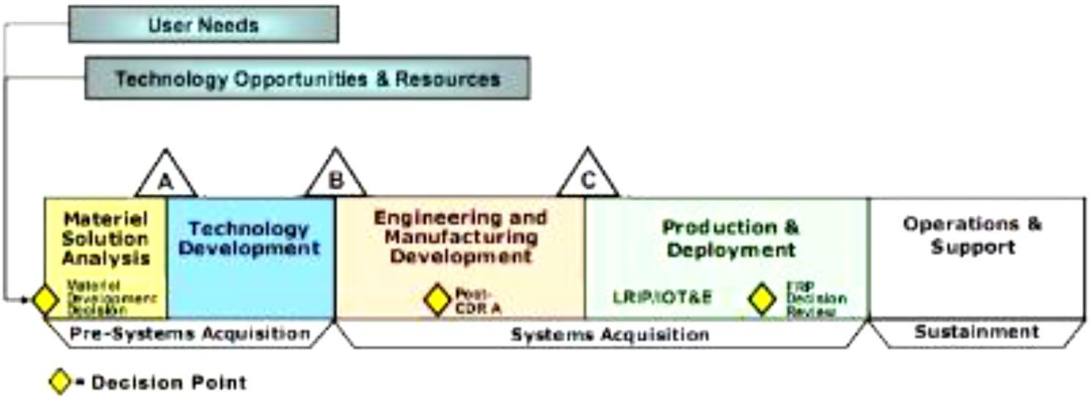


Figure 13: United States DoD 5000 Defense Acquisition System Life Cycle (Archibald et al., 2012)

2.2 General Project failures & Causes

Any project not delivered in line to the expectation as agreed in the business case is failed project. Projects often fail in terms of costs, times and quality (Oakes & Oakes, 2012)

Organizations such as the Standish group and the UK's Office of Government Commerce (E.g. OGC, 2002, 2004b, 2006) identified some of the causes for project failures as below (Oakes & Oakes, 2012)

- Success criteria, scope and requirements are unclear or unrealistic: Lots of time at the time of framing the business case and before it is approved projects fail to review requirements in detail, and identify the deliverables.

- Poor planning: Inefficient planning causes a project to fail. Planning is a crucial factor for project success.
- Managers fail to take ownership of the project or fail leadership to steer project in right direction
- Lack of proper communication among different stakeholders
- Inaccurate cost estimation during various – there are instances when the cost of an undertaking is grossly underestimated.
- Inadequately-trained project managers – Large complex projects with poorly trained project manager’s results a project failure.
- Unrealistic schedules and plans
- Misestimating of capabilities of suppliers, technologies and tools
- Failure to perform key processes, such as communications, quality management, risk management, change management etc.

While referring to project failures on the Norwegian Continental Shelf (NCS), Norwegian Petroleum Directorate (NPD) work reveals that especially are four issues in project implementation which is essential for a project to succeed (NPD, 2013)

- Thorough work in the design phase, that is in early stages. This will form the basis for decisions and further work in the project
- A clear contract strategy that takes into account the main risk elements of the project, such as the use of new technologies and major equipment components
- Thorough pre-qualification of suppliers that contribute to the project
- Good follow-up of the project operator. This is crucial regardless of where in the world the construction takes place.

2.3 Projection evaluation methods

Project Reviews:

Assessment of the status of a project at any point of time during project lifecycle can be called a project review. Project reviews helps in decision making. Project review is carried out during the "Initiation" phase to ensure the objectives are met. During this project review is carried out to ensure the objectives are met and is approved to proceed to the next project phase. These project reviews at the end of each phases allows better progress control.(Oakes & Oakes, 2012)

Benefits of Effective Project Reviews:

- Earlier identification of risks and issues which help in lowering project costs and failure rates. In extreme scenarios it facilities to take a decision to suspend the project, thus reducing the investments in failed projects
- Adopt best practices learned elsewhere which can be incorporated in later project stages for smooth running
- Improved communication among stakeholders and project team

Types of Review:

According to Association for Project Management there are five types of review namely (Oakes & Oakes, 2012)

1. Evaluation review: Project progress is evaluated against the original planned schedule, budget, promised deliverables. This shall be done at any time during the project lifecycle. These reviews measure the effectiveness of project management, evaluate likelihood of project success and also identify concern area(s) that needs some corrective actions.
2. GATE review: This GATE review is done at the end of each project phases in a typical project lifecycle. These GATE reviews ensure the requirements are met in each phase before proceeding to the next phase.
3. Audit: Audits are an evaluation by an external team (not the project team) to evaluate if the project milestones /deliverables are achieved. E.g. Quality audits, Risk audits etc. Audits assesses whether the project is operating in accordance with the relevant policies and standards.
4. Post-Project Review: This happens at the end of project closure to understand what went right and what went wrong in the project. It generates lessons learnt for future project undertakings
5. Benefits realization review: This is used to see if the benefits identified in the business case have been achieved.

Timing of the Reviews:

There are 3 options for timing of the reviews (Oakes & Oakes, 2012)

- Event based: Reviews can happen at key times in project lifecycle. Example Gate reviews coincides with points such as the decision to initiate procurement, sign a contract or commit to a particular design. GATE aids to ensure that the information is available for needed decision making. Other event based reviews such as post project reviews helps in determining how well the project is delivered against plans made and provides good lesson learnt for future.
- Periodic: These can happen at regular intervals throughout the project (eg., weekly conference to understand progress)
- Ad hoc or one off reviews: These are also called health checks. These are typically setup to answer specific questions about a project

Project Evaluation Cycle: Evaluation is not a stand-alone one time activity but should be throughout project lifecycle. The figure below depicts clearly about Project evaluation cycle.

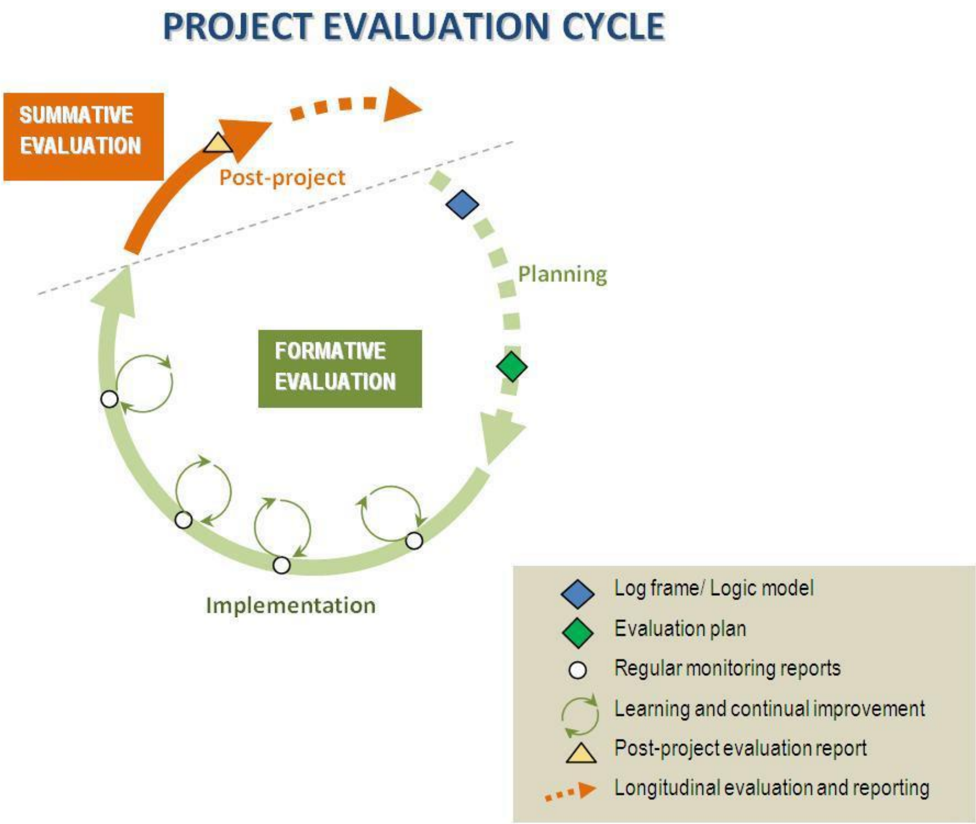


Figure 14: Project evaluation cycle (Swinburne, 2011)

<u>Attributes being reviewed:</u>

Reviews typically focus on various attributes namely (Oakes & Oakes, 2012),

-Objectives: Are the objectives clear, well understood by stakeholders, aligned to organizational objectives and does the business case still hold up?

- Status: Project progress against the planned budget, schedule & deliverables

-Risk: Risks that are faced by the project & management of these risks

-Quality: this can refer to quality of products to meet the relevant technical standards

-Process: check if the project is following appropriate processes, example for planning, status tracking, change management, risk management etc.

-Compliance: Checks if the projects is complying with policies, standards and processes

Table 1 : Examples of standards applying to different attributes of the project (Oakes & Oakes, 2012)

Attribute	Baseline	Reference models
Objectives	Organizational strategy Business case	Methods such as sensitivity and options analysis
Status	Project plan, schedule and budgets Earlier status reports	Organizational standards for status tracking and reporting Standards techniques and metrics such as Earned Value
Risk	Business Case Project plan Earlier versions of risk registers	Organizational standards for risk management Standards approaches and models for risk management Checklists of lessons learned from earlier projects
Quality	Quality plan Specifications Test plans	Relevant ISO, IEEE and other standards Relevant regulations and legislation Organizational policies, standards and guidelines
Process	Project Plan	Bodies of knowledge such as APM, PMI Methodologies such as PRINCE 2 etc
Compliance		Relevant quality process standards, regulations

Challenges of Running Effective Reviews:

The project reviews help projects to be realistic. These reviews could vary from formal gateways to informal evaluations.

Then why are the failing? Why are we not able to use the reviews to capture the problems early and resolve?

The below are the challenges faced by project teams in conducting the reviews (Oakes & Oakes, 2012)

- Limited time and resources for conducting the reviews. Also it can be difficult, and extremely frustrating, to get people to act on the findings from a review.
- Getting the Organizational support for reviewers is another challenge. It’s difficult to persuade organizations to invest systematically in reviews.

If reviewers have a clear model of the process they will undertake, they can focus their energy on defining the objectives and gathering and analyzing information. Without this clear model, time gets wasted simply thinking about what needs to be done next. Also currently there are various templates to monitor different project phases (Oakes & Oakes, 2012)

1. Initiation phase: Business case , Feasibility study report, Project charter Project office checklist, Phase review form
2. Planning phase: Project plan, Resource plan, financial plan, risk plan, quality plan, acceptance plan, communication plan , procurement plan
3. Execution phase: Quality management form, timesheet form, expenses form, change management form, risk registers, acceptance management forms etc.
4. Closure phase: Closure report & post implementation review form

Thus we see that there is no single template for complete project evaluation. People use different templates for project evaluation as mentioned above. Many projects sometimes don’t use decision/stop gates as a method of evaluation.

2.4 Standard Project model for Oil Industry/Heavy industries

The figure below depicts a standard project model in offshore oil & gas industry. Each of these phases contain critical decision points (proceed, cancel, revise scope/cost/schedule/quality.)

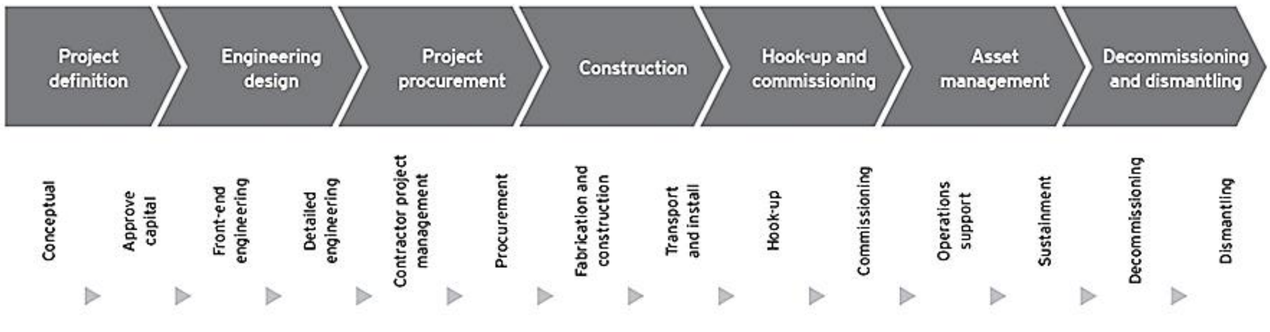


Figure 15: Standard Project model for Oil & Gas Industry (Barton, 2015)

<u>Planning stage of Project (FEL):</u>

FEL-Front-end loading also referred as conceptual planning /early project planning/ pre-project planning stage is widely adopted approach in many heavy industries, aviation, navy, pharmaceutical and energy industries. Early planning through FEL helps to avoid expensive changes during implementation stage of the project (CII, 2012).

Front End Planning can be divided into 3 main phases namely: 1. Feasibility 2. Concept 3. Detailed Scope.

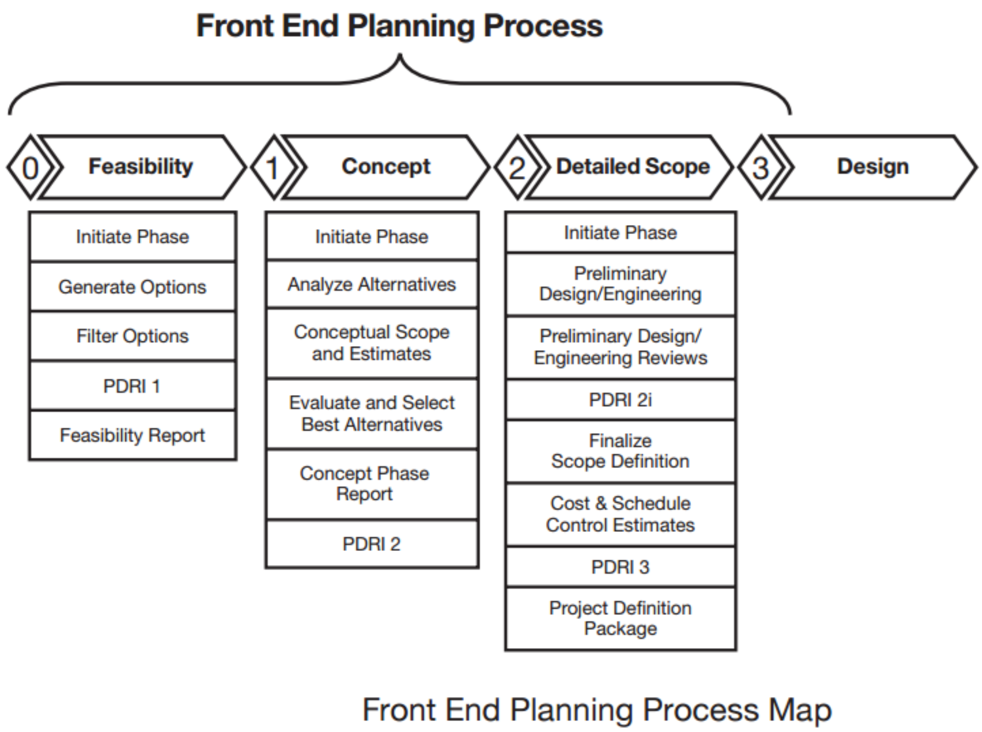


Figure 16: Front End Planning Process Map (CII, 2012)

Results of good Front End Planning:
Cost: 10 percent less
Schedule: 7 percent shorter delivery
Changes: 5 percent fewer

<u>Contracting Strategies</u>

All heavy industries (oil & gas, aeronautical, navy etc.) generally follow an EPCI model for project execution. Engineering, Procurement and Construction (EPC) Contracts are a common form of contract for large scale and complex oil and gas projects. This also extends to EPCIH model (E-Engineering, P- Procurement, C- Construction I- Installation, H- Hookup)

Oil & gas projects vary in project complexity & sixes and it is always a real challenge to meet the desired costs, quality & completion dates. The type of contract strategy chosen will have a great deal of impact on final project deliveries. Thus there are four types of contract strategies namely (Carolin Schramm, Alexander Meibner, & Weidinger, 2010)

1. EPC Contract (Engineering, Procurement & Construction): In this contract type a contractor is delegated responsibility of supplying of materials & equipment, all design, engineering, construction, installation as well as commissioning, start-up and testing activities (Carolin Schramm et al., 2010)

In this contract strategy the contractor is desired to deliver all the products (complete facility or plant) according to owner's requirements, agreed schedule and with desired quality. The EPC contractor shall provide all communication with the owner and the risks (all economic, schedule etc.) are transferred to the contractor. The owners task is only contractual management (with the EPC contractor) and interface management (eg. management of communication, coordination etc.). This relationship is shown by figure below (Carolin Schramm et al., 2010)

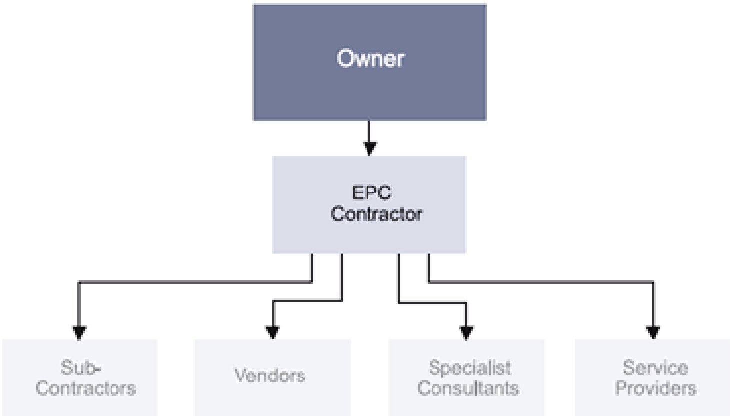


Figure 17: EPC Contract Model (Carolin Schramm et al., 2010)

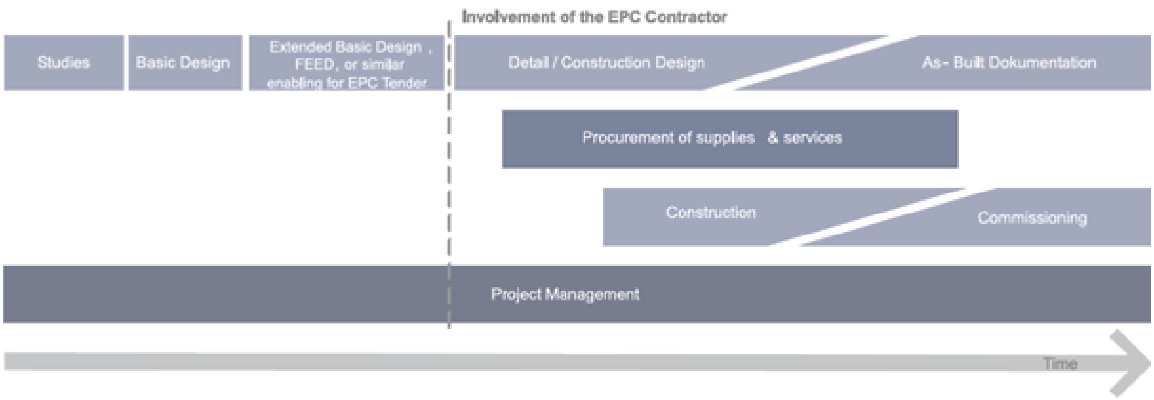


Figure 18: EPC -Qualitative Time Schedule (Carolin Schramm et al., 2010)

The owner also may award the project management services (such as consultation, advice, supervision of the contract etc.) to a Project Management Consultancy (PMC) who shall do the project management interfacing with the EPC Contractor (Carolin Schramm et al., 2010).

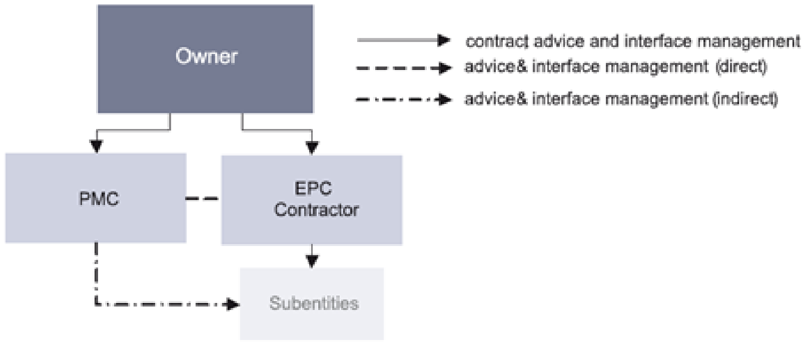


Figure 19: PMC Contract Structure (Carolin Schramm et al., 2010)

Key features of this EPC Contract form (Carolin Schramm et al., 2010):

- Complete project delivery responsibility lies with the contractor
- Clear division of obligations and liabilities
- It has a negative impact on schedule due to the long time involved in tending the EPC contract and due to the high time in initial Engineering phase

2. EPC with LLIs (Engineering, Procurement, Construction with Long Lead Items): In this type of contract the owner procures the long lead items (material and equipment with long delivery times) before awarding the EPC contract (Carolin Schramm et al., 2010). This contract relationship is shown below

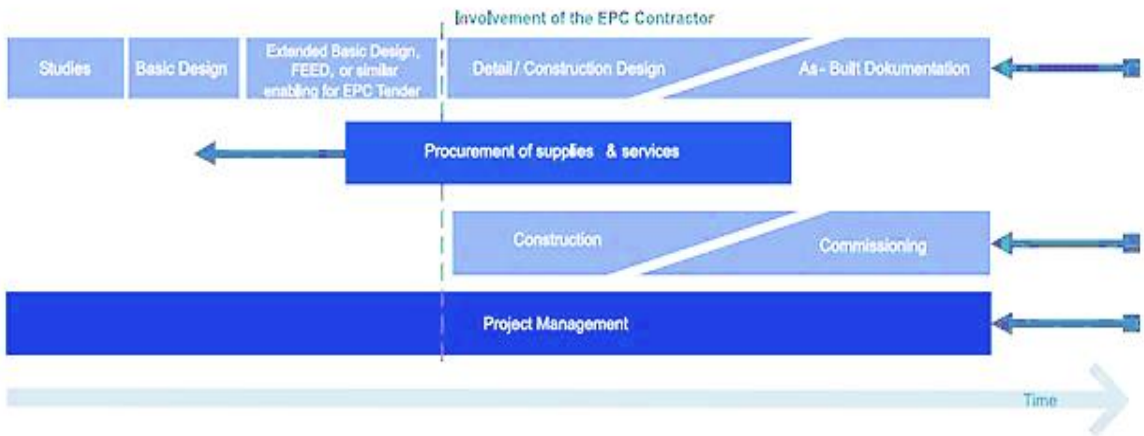


Figure 20: EPC with LLI- Qualitative Time Schedule (Carolin Schramm et al., 2010)

The key features of this contract are:

- Project schedule is shortened (due to early procurement of the long lead items)
- Risks are transferred to the owner (since procurement & selection of vendors lie with the owner)

- This contract increases the interface management of the owner (owner needs to have communication with vendors as well as EPC contractor)

3. EPCM Contract (Engineering, Procurement and Construction Management):In an EPCM contract, the owner contracts an engineering company to provide the engineering, procurement and construction management services (Carolin Schramm et al., 2010). Since the contact is owned by the owner and managed by EPCM contractor the risk (cost & schedule) lies with the owner. EPCM contractor handles all the activities and even assists in discussing the contractual relationships between the owners and its vendors (like construction contractors & materials suppliers).

Key characteristics of this contract are:

- Full project control lies with the owner
- Good interface management (good communication etc.)
- Schedule, contractual, technical, commercial risks lie with the owner

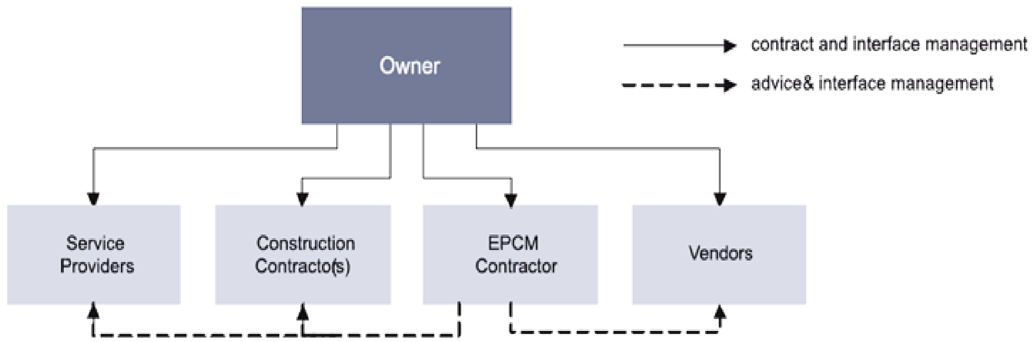


Figure 21: EPC with LLI- Qualitative Time Schedule (Carolin Schramm et al., 2010)

4. PLM Contract (Progressive Lump sum Strategy): In this type of contract the EPC contract is broken down into several lump sum contracts. This means each contract is based on the cost estimates (Carolin Schramm et al., 2010)

The Figure below shows the risk distribution in various contract strategies

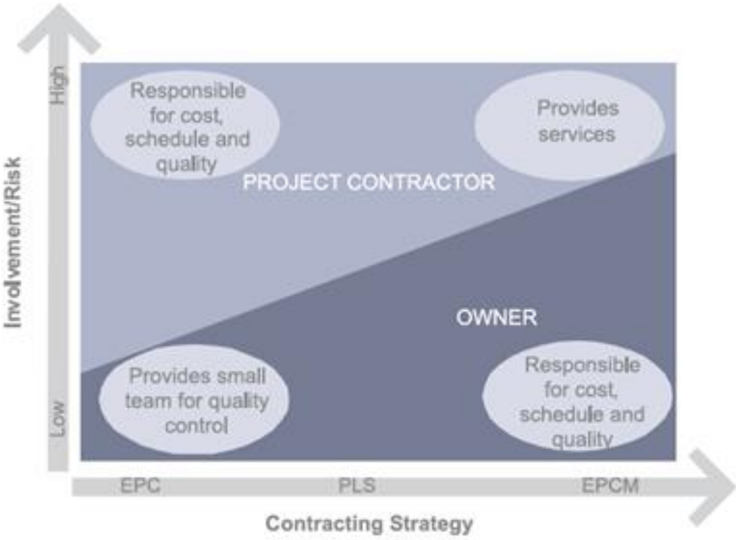


Figure 22: Risk Distribution in various contract strategies (Carolin Schramm et al., 2010)

<u>Importance of good FEED (Front End Engineering Design):</u>

FEED is vital part of the lifecycle in a project. FEED is done after concept evaluation and before detail design. FEED focuses on the technical requirements, rough initial cost estimates & determines project feasibility. It forms the basis for next contracting phases of the project. FEED helps in identifying critical equipment & long lead delivery times and thus enables the procurement activity to start before the main contract is awarded. A good FEED should reflect client's project specific requirements; avoid significant changes during the execution phase. There exists some close communication between Project Owners, Operators and the Engineering Contractor during the FEED phase. The following is the output of a good FEED (Loots & Henchie, 2007).

- Estimate preliminary project schedule
- Establishes project budgets (Capex & Open)
- Helps in establishing good project risk management plans
- Establishes equipment specifications, preliminary equipment lists, initial design drawings
- Helps in Evaluation of supplier submissions, establishes statutory/regulatory requirements
- Helps to formulate Scope of Work for project execution

Importance of the Concept Selection:

"Right" Concept selection is the stepping stone to success for the following FEED, preliminary engineering, and detail engineering & execution phases of the project. Thus "right" concept selection will have a major impact on the success of the project. Decision making in the concept selection phase is influenced by several factors like nature and complexity of the project, client requirements, water depth or location, various issues such as government/regulatory mandates, company standards, past experiences from similar projects etc. (Rapp, 2007).

Major drivers of the conceptual phase are (Rapp, 2007):
Capturing Relevant Information- This includes extracting field data (like reservoir data, pressure/temperatures), drilling requirements (includes timing of drilling, no of wells , types of trees to be installed, workover options, type of rigs etc.), operational conditions(such as expected uptime, flexibility needed, discharge requirements, flow assurance issues) ,filed planning (this includes distance from wellheads, looking at the flow lines, risers, export of oil/gas to nearby hubs etc.) , regulatory policies, safety issues, tolerances for risk etc.

Concept team selection: This includes using the expertise of most experienced personnel, Identifying contractors who have similar project experience, consider partners in FEED with good prior knowledge, detail design, and project execution strategies. During selection of the concept team biases of personnel (example client might choose a structure from past projects though current reservoir conditions demand need for alternatives, situations like contractors having certain preference to a specific hull design etc.) should be carefully considered.

Communication: Client's project drivers such as cash flow projections, safety, quality, schedule etc. should be well communicated to all stakeholders. Early and complete alignment is critical. Misunderstanding of the requirements leads to rework and thereby escalates costs. Thus a proper communication is vital

Concepts for consideration: During concept selection existing and new technologies should be considered and evaluated. Concepts priority is based on factors such as costs, schedule, execution plan, and risks (both technical as well as commercial).

This is shown by the Figure shown below

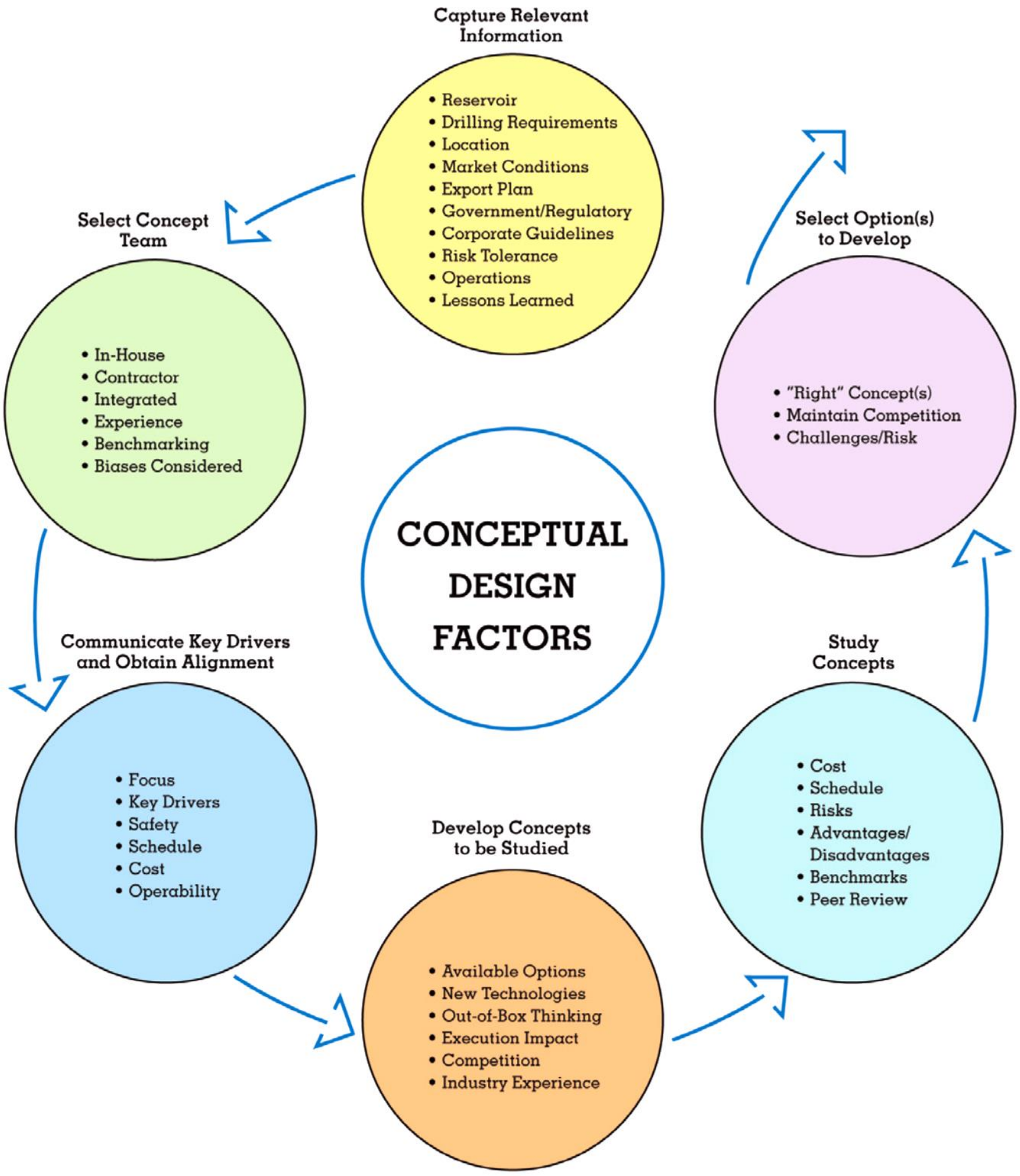


Figure 23: Conceptual Design Influencing Factors (Rapp, 2007)

2.5 NCS Project Full Field Development Model

The figure below shows a typical Project Implementation model for the whole field which is widely used on the Norwegian shelf. Multiple decision points throughout the project's lifetime is followed in this model.

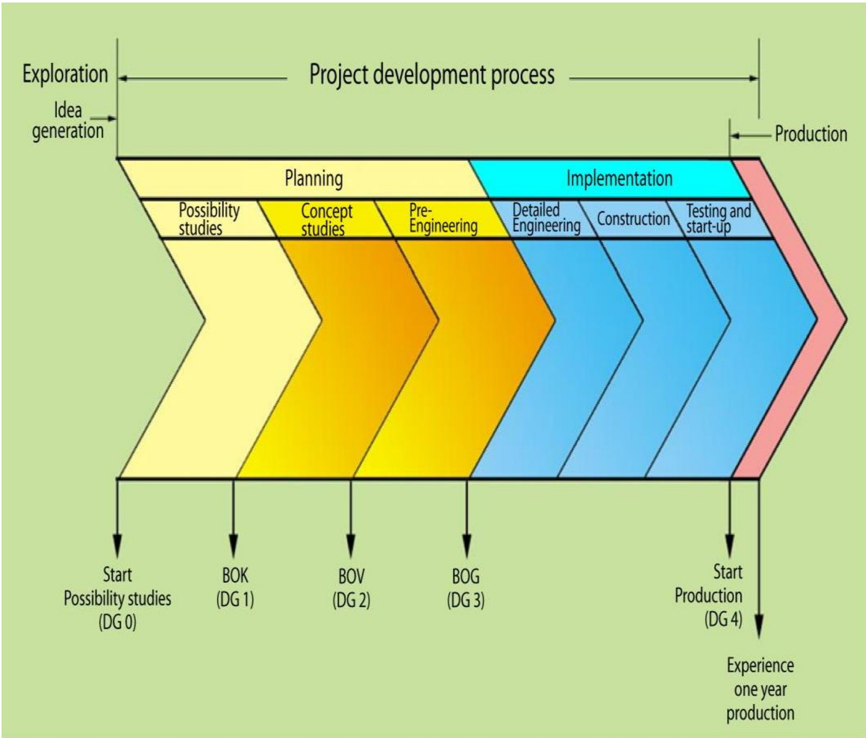


Figure 24: General NCS Project full field development model (NPD, 2013)

2.6 Gated Process

<u>Introduction to Decision GATES</u>

Formal points of control in a project lifecycle is achieved through using the decision gates. The concept ensures that the project can proceed to the next phase only with formal approval only. Decision gates are termed as stop/go reviews since it ensures that there is no authority to proceed without renewed delegation.

Decision gates can be applied at all levels in an organization, for example:

- Corporate level- such as budgeting approvals for key investment decisions
- Programme level- for getting the approvals for project
- Project level- for getting the stage level approvals
- Team level - this can be done at a work package level to get the product approvals

STAGE GATE PROJECT MANAGEMENT PROCESS:

Since Gate reviews are categorized as Quality Assurance since they focus more on the processes completed (rather than reviewing any specific deliverables). A Stage Gate Process is a structured approach toward project management for properly managing large and complex projects.

All industries such as pharmaceutical, chemical, metallurgical, aviation, mining, & around 70-85% of leading U.S. new product development companies use Stage-Gate Process (Biljana & Radul, 2014). Stage GATE optimizes shareholder value by improving the quality of project decisions and thereby increases the success of the projects. Though Stage GATE Process is also implemented in the Oil & Gas Industry, it is not widely used on the Norwegian Continental Shelf.

The STAGE GATE process not only provides the best compromise between expenditure and estimate accuracy but also provides a controlling framework to ensure that the project teams develop the design in the most cost and schedule efficient (Lawrence, 2008). Project estimates (costs/schedule) are made in each GATE and this undergoes project & management approval to go ahead to next stage i.e. a decision to either proceed to the next phase, re-do the phase, or stop the project.

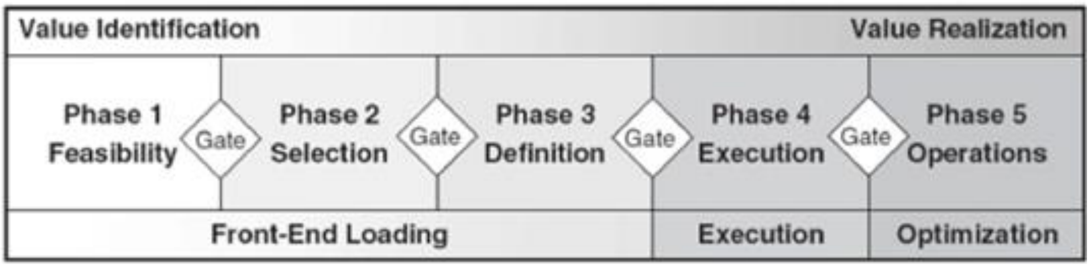


Figure 25: Stage GATE PMP Outline (Megginson, 2012)

The importance of efficient decision making during the FEL stage (specifically during the feasibility & selection phases) is depicted in the figure below (considering a typical energy project). Most of a project's value is created during the first two phases. The below graph depicts two curves (splitting at the end of the Feasibility Phase) which corresponds to the value creation generated through the usage of appropriate project frame (usage of Decision Gates/Stage Gates) versus the destruction of value (through the non-usage of Decision Gates).

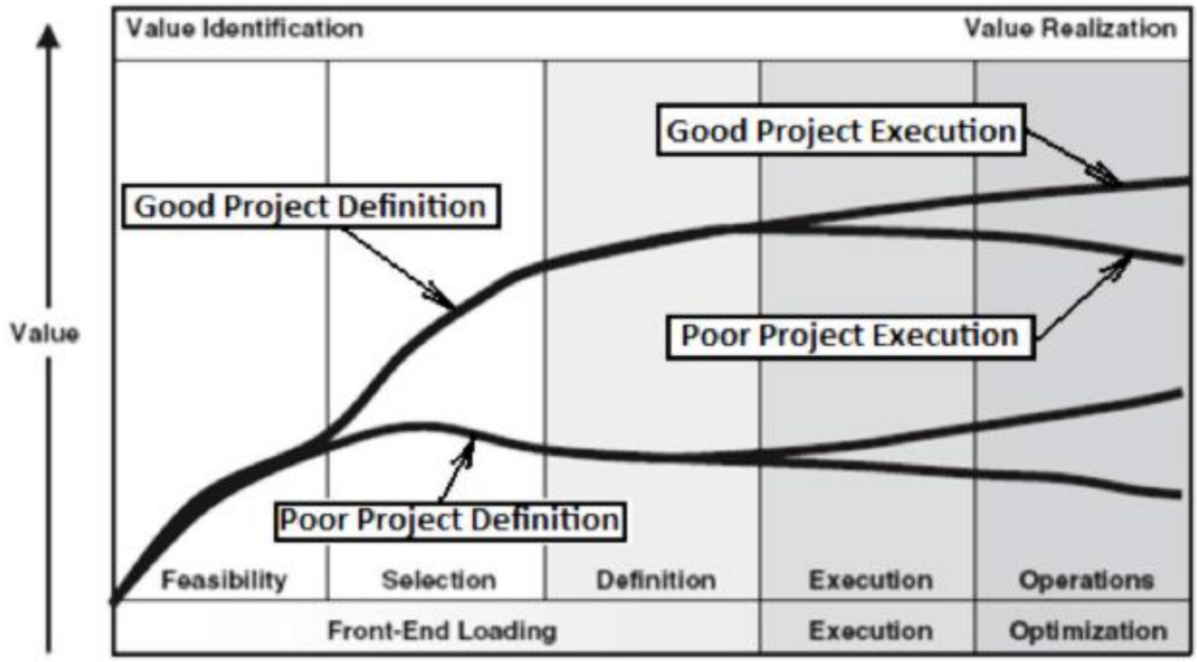


Figure 26: Value Creation in a Project (Megginson, 2012)

The Gate Review Meeting - A Two Step Process:

The figure below describes how the decision is made in a gate review meeting

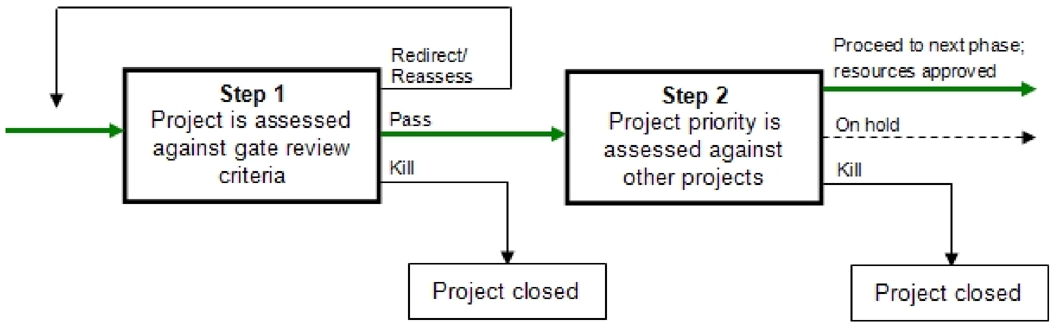


Figure 27: Gate Review Process Steps (Solutions, 2016)

<u>Benefits of STAGE GATE approach in oil industry:</u>

Stage Gated model is one of the best approaches to manage large capital projects. This gated approach encourages collaboration among different phases. The benefits of the STAGE GATE approach in oil industry is described under.

- There will be lesser rework in FEED (Front End Engineering Design Stages)
- It provides good decision support to suspend a project if needed
- It improves cycle time for certain stages

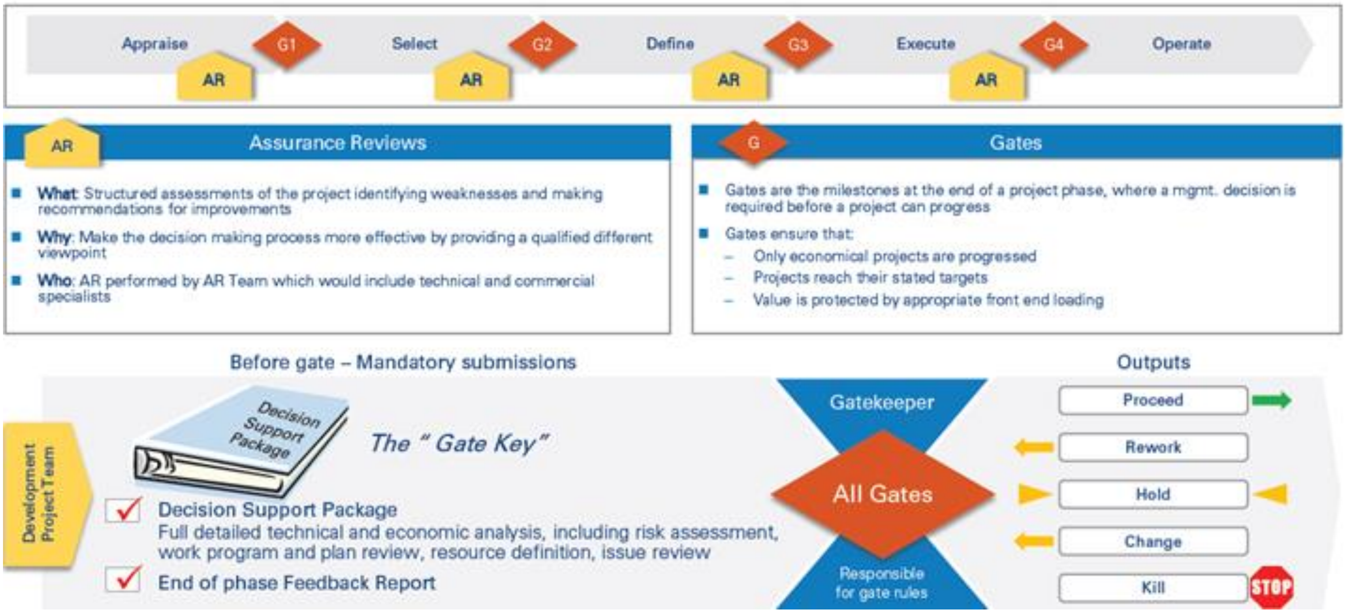


Figure 28: Good Practice Stage GATE Process (Little, 2012)

Typical Gated Process in Oil Field Project Life Cycle

The Figure(s) shown below shows the Stage GATE process in oil field project lifecycle.

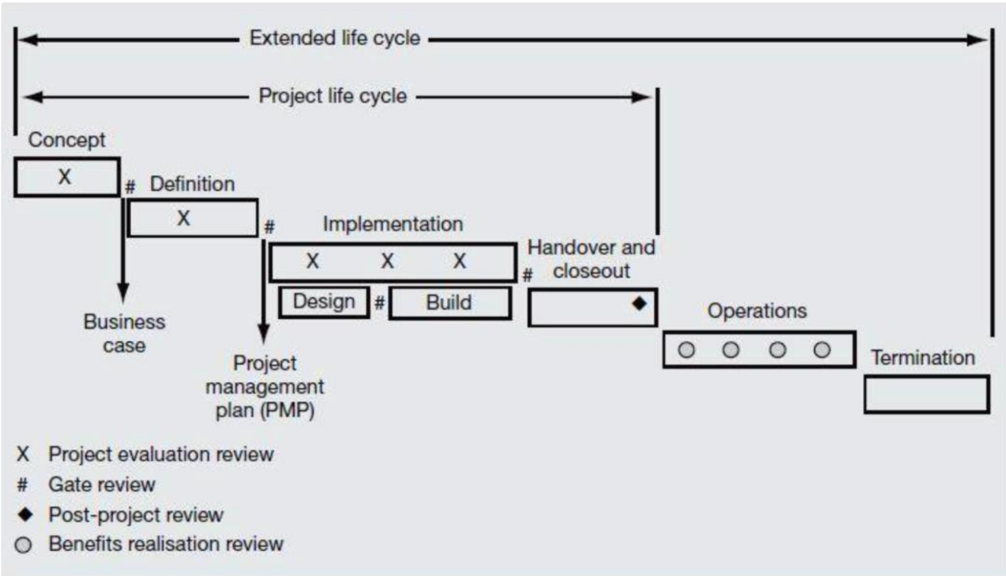


Figure 29: Typical Gated Process in Oil Field Project Lifecycle (Archibald et al., 2012)

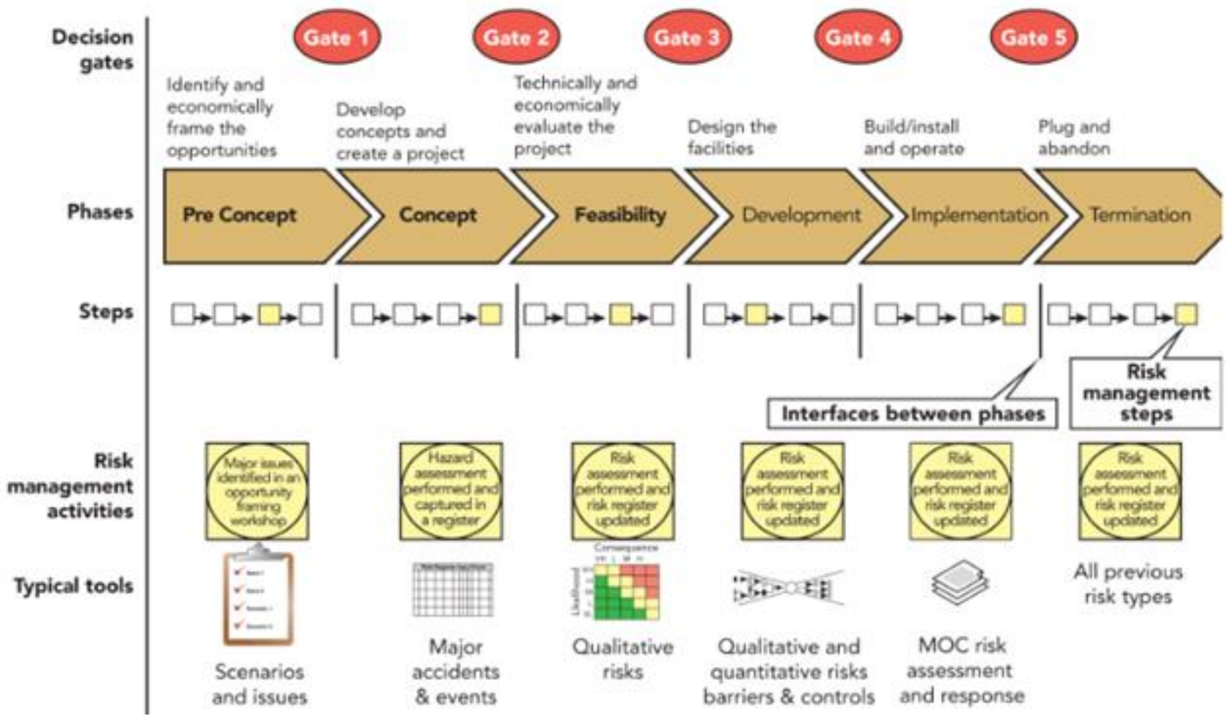


Figure 30: Typical Oil & Gas project delivery process over life cycle of well (Randall, 2010)

Typical estimates for Gate Approval in Oil Field development process:

The figure below shows typical accuracy of the estimates needed in the concept phase, study phase & FEED phase for oil field development

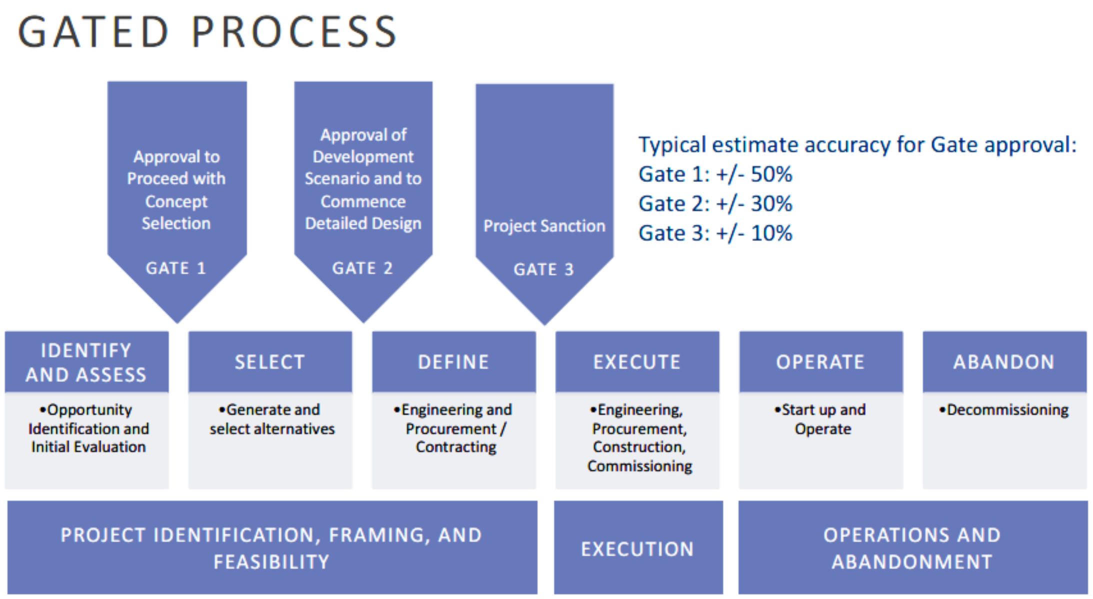


Figure 31: Estimate accuracy for gate approval in oil field development process (RISC, 2010)

2.7 PRINCE 2 Project Model

What is PRINCE2 Project Model:

PRINCE2 (Projects IN Controlled Environments) is effective project management developed from the experience of numerous projects study. It provides a method for managing projects effectively within a clearly defined framework. It supervises project activities and steers the project in the correct direction when any challenges are faced during the project execution. On the basis of close monitoring, the project can be carried out in a controlled and organized way. PRINCE2 can be applied to a wide variety of projects (IT, aerospace, engineering, construction etc.) ranging from smaller scale size to a typical larger ones. This is widely used methodology in the UK sector currently being used widely throughout the world. PRINCE2 methodology will enhance the project success using a structured approach to solve issues arising during running the project.

The PRINCE2 method encompasses the four integrated elements as shown below:

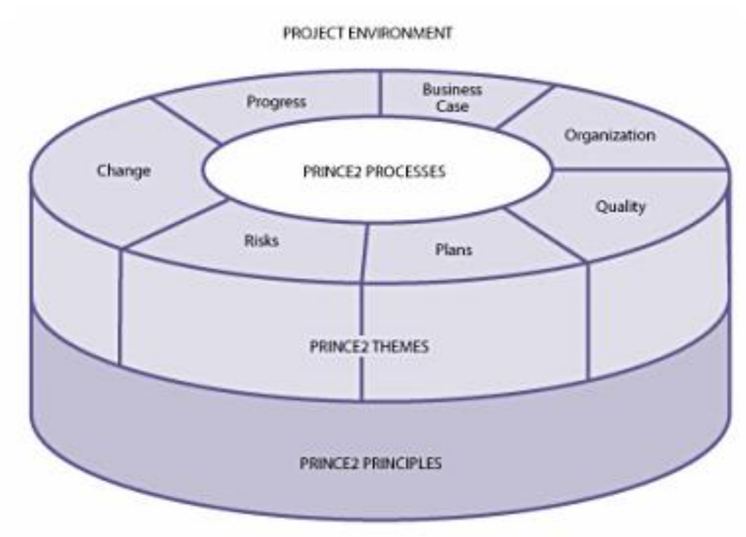


Figure 32: PRINCE2 Method (Murray, Bennett, Bentley, & Great Britain. Office of Government, 2009)

Principles: There are seven principles which act as a guiding obligations and good practices namely (Graham, 2008; Murray et al., 2009)

1. Continued business justification-This principle looks at if there is a justifiable reason for project to start
2. Defined roles and responsibilities-According to PRINCE2 the organizational structure should have the right people with right expertise
3. Manage by Stages-This philosophy of PRINCE2 is that projects have to be planned, monitored and controlled Stage by Stage basis.
4. Manage by exception-Project shall be managed through an approved except plan according to PRINCE2

5. Learn from experience- This states that project teams shall implement lessons learnt from previous work
6. Focus on products
7. Tailor to suit the project environment

Themes: The aspects of project management that need to be taken care of throughout the project are captured by these themes. The seven themes as described by PRINCE2 are (Murray et al., 2009)

1. Business Case: Business case helps to assess if the project is viable , remains desirable, and thus support decision-making for investment purposes
2. Organization: Project's structure roles, responsibilities are defined
3. Plans: Establishes control mechanisms for product deliveries with respect to project schedule.
4. Quality: Description of the quality standards to be used and on agreed process to make sure the products are fit for the purpose
5. Risks: Identify, assess and control uncertainty
6. Progress: Establish mechanisms to monitor and compare actual achievements against planned (to track the progress). An exception report if the tolerances are forecast to be exceeded to help the sponsor to decide
7. Change: This identifies any potential changes to baseline

Processes: Processes describe stepwise progression through the lifecycle of the project. The seven processes are (Murray et al., 2009):

1. Starting up a Project
2. Initiating a Project
3. Directing a Project
4. Controlling a Stage
5. Managing Product Delivery
6. Managing a Stage Boundary
7. Closing a Project

This is shown by Figure below

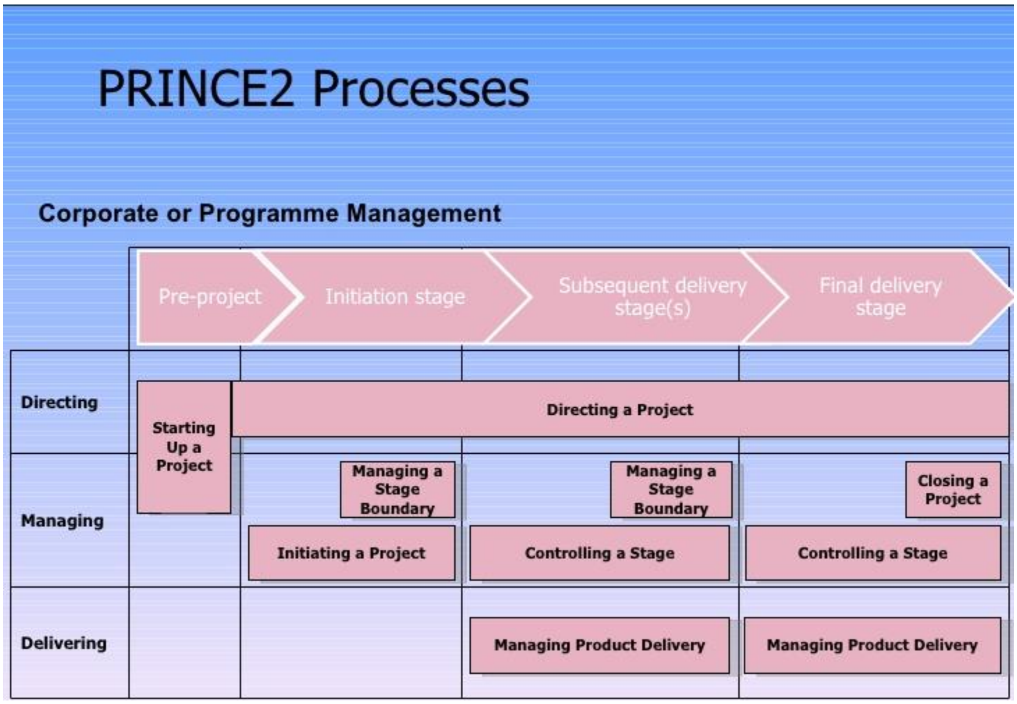
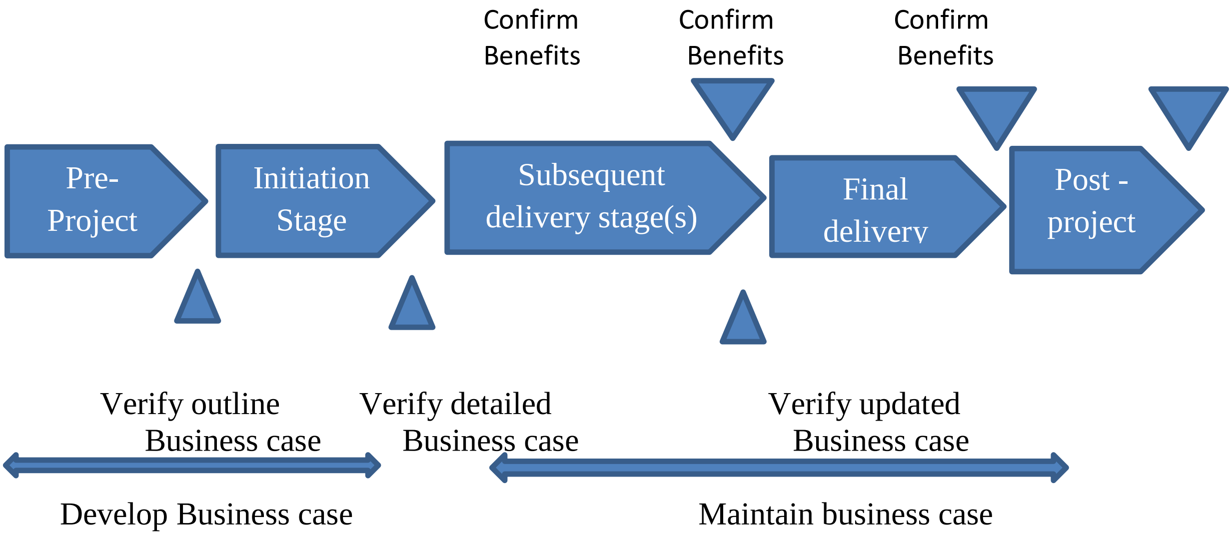


Figure 33: PRINCE2 processes through the project lifecycle (Murray et al., 2009)

Starting up a Project: The following are some of the activities done in this Stage (Murray et al., 2009)

1. Execute and the Project Manager are appointed
2. Previous Lessons are captured
3. Project management team is identified and established
4. Outline Business Case is prepared

What is Business Case: It typically contains an executive summary of the project, business options, expected benefits of the project, expected dis-benefits, timescale of the project, costs, investment appraisal, major risks etc. (Murray et al., 2009)



The business case shall be reviewed continually as stated below to drive the decision making process (by project management or corporate management) (Murray et al., 2009):

1. It shall be done at the end of the pre-project phase by project board to authorize the project initiation (based on a reasonable justification)
2. At the end of the initiation stage to authorize project starting
3. It shall be done at the end of each stage by the project team to find out if any costs, timescales, risks etc. are to be updated
4. This shall be done in tandem with an exception plan (submitted by project manager to the project board) in order to authorize the revised stage and continuation of the project
5. At the end of each stage to get approval for the project to continue to the next stage
6. This shall be done at the end of the project to assess the projects performance against its requirements.

PRINCE2 suggests that a project must have continued business justification throughout the project phases which ensures projects to Succeed. Business case justifies the project based on the estimated costs, risks and the expected benefits.

Directing a Project: This process provides approval for project initiation, project authorization, provides ad hoc direction, if needed and also authorizes stage or exception plan.

Project only starts only when the green signal is received from project board. The performance of the current stage shall be reviewed by the project board and approval for the next stage is provided (Murray et al., 2009). For any exception that had occurred at any stage, the project manager shall submit an exception plan to project board for approval. (e.g., situations like exceptions to project plan shall be submitted to project board by project manager). This is the **principle of management by exception** followed by PRINCE2. Exception plan when approved shall become the new baseline plan.

Initiating the Project: Once decision is obtained to go ahead with the project, we need to secure the funding, establish the project controls and have detail planning. Thus this stage covers all the above aspects. This is a very important stage after authorization to ensure: quality, project plan, refined business case and risks to execute project and project controls are set up correctly.

Subsequent Delivery Stages: Project manager ensures the project is progressing in line with the approved plan and within the acceptable tolerances through the usage of project controls such as daily log, lessons log, issues register, risk register, quality register etc. (Graham, 2008). The Project Manager informs about the progress to the top management.

Controlling a Stage Process encompasses the activities to control each stage. This stage ensures focusses on the delivery of the stage products. Deviations from stage is monitored to avoid Changes in scope ("scope creep"). This controlling measures ensures that risks &

issues are kept under control and thereby ensures that the products are delivered to needed quality standards, within agreed cost and time.

Controlling a Stage consists of (Murray et al., 2009):

-Work Package: Authorizing a Work Package, Review Work package Status, Receive Completed Work Packages

-Monitoring and Reporting: Review the stage status, Report highlights

-Issues: Capture & examine issues/risks, Escalate issues/risks and Take Corrective action

Work packages are used a means to control the work to be done at this stage. Throughout the cycle of controlling a stage the following is followed

1. Authorizing of the work to be done

2. Monitoring progress information about that work, including signing off completed work packages

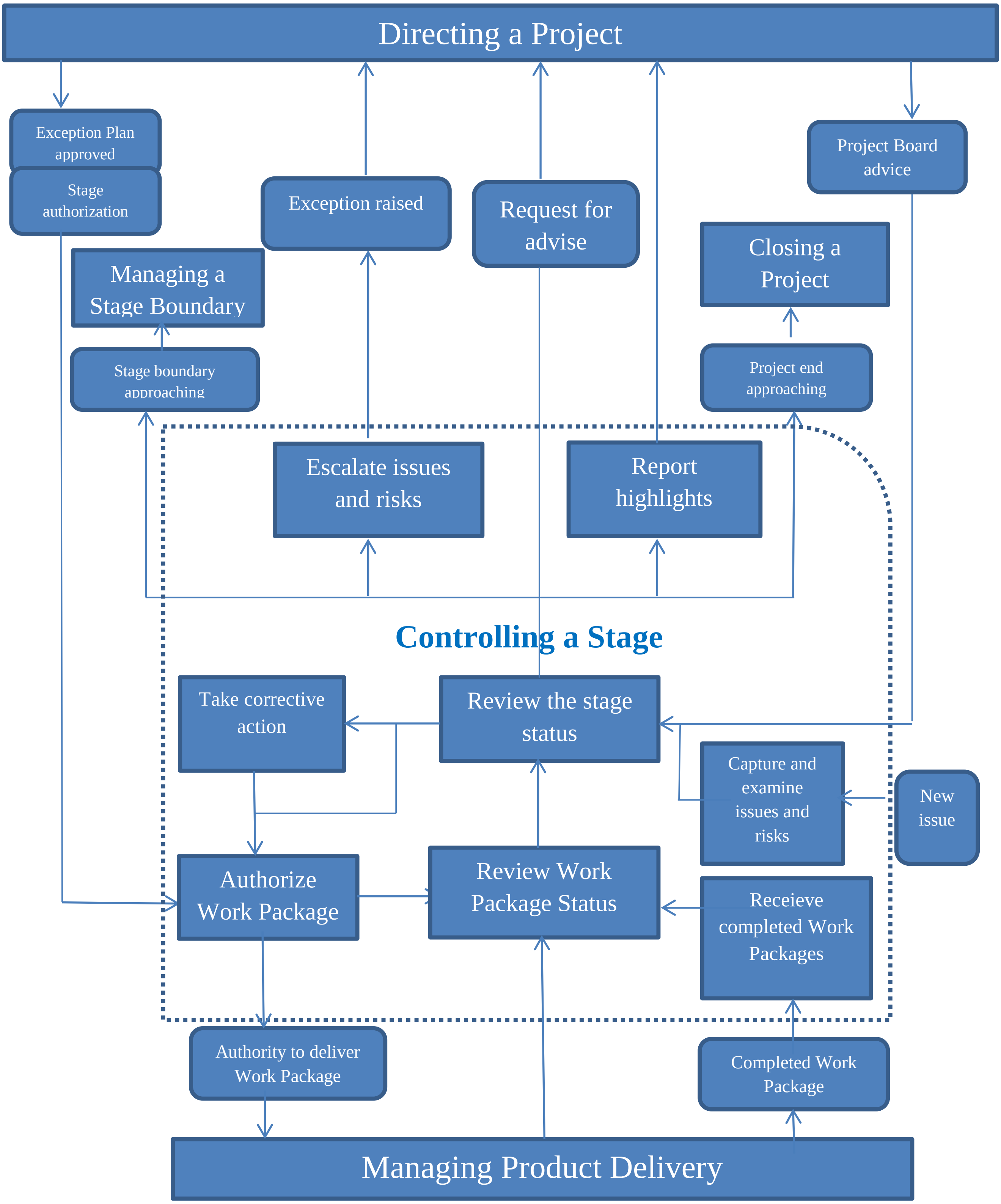
3. Reviewing the situation and triggering new work packages

4. Reporting highlights.

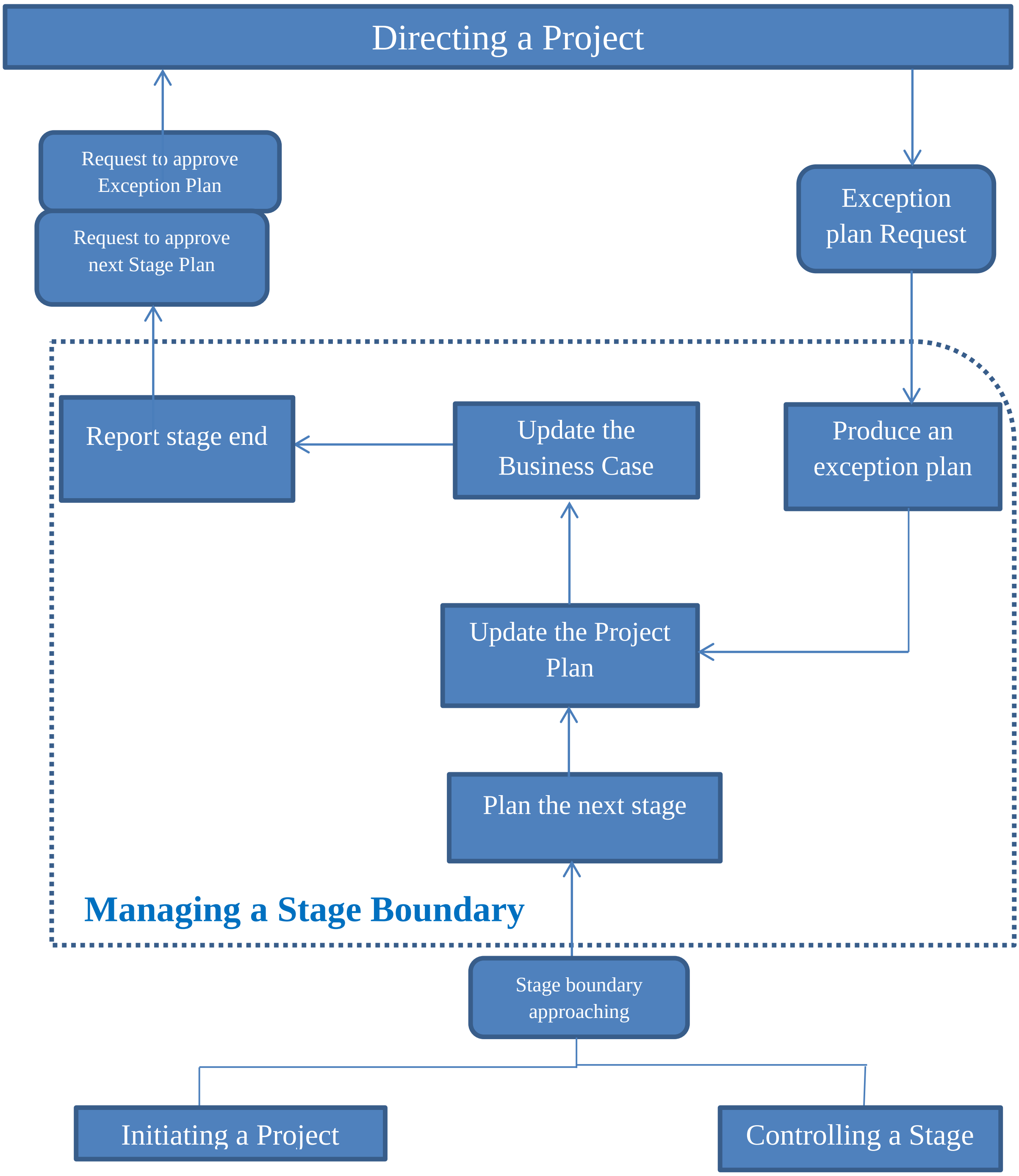
5. Watching for, assessing and dealing with issues and risks

6. Taking any necessary corrective action

This process is shown by the flowchart below (Murray et al., 2009)



Managing a Stage Boundary: The process of Managing a stage boundary ensures that at the end of each stage sufficient information is provided by the project manager to the project board so that the success of the current stage is reviewed, provide approval for the next stage plan, update and review the updated project plan, ensure continued business justification and provide acceptance for the risks. This process shall be executed at the end or close to the end of each management stage. The process is shown by flowchart below(Murray et al., 2009)



Managing Product Delivery: The essence of the Managing Product delivery Process is to ensure that

-Work on products allocated to the team is authorized and agreed

- Suppliers & Team members, are clear of the agreed deliverables (within the defined costs, schedule)

-Planned products are delivered to expectations and within tolerance.

This is essentially project package and break down to levels as necessary.

If we consider for an EPCIC model this essentially breakdowns the project to different package level E.g. Hull, systems, propulsion, cranes and lifting, controls, safety, Fire &Gas, Vessel control, Fire Water Pumps, Compressors, Helideck Fire Fighting Equipment, etc.

The figure shown below gives an overall overview of the PRINCE2 Project Model (Murray et al., 2009). The figure shows the overall process followed by PRINCE2 and shows the various checklists that are used for project initiation, project planning, project execution and project close out phases. The flowchart shows the PRINCE2 Process flow model (Murray et al., 2009).

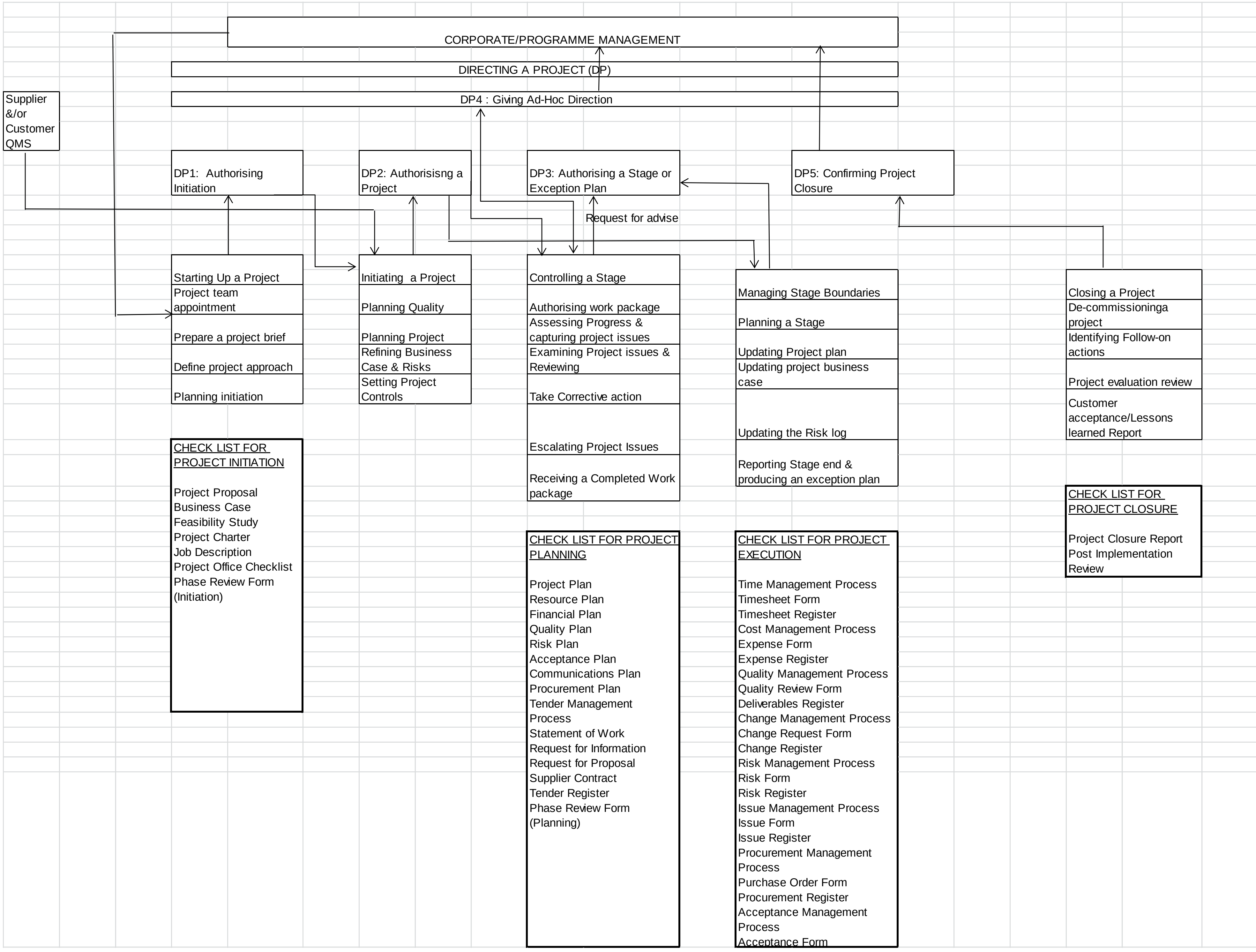
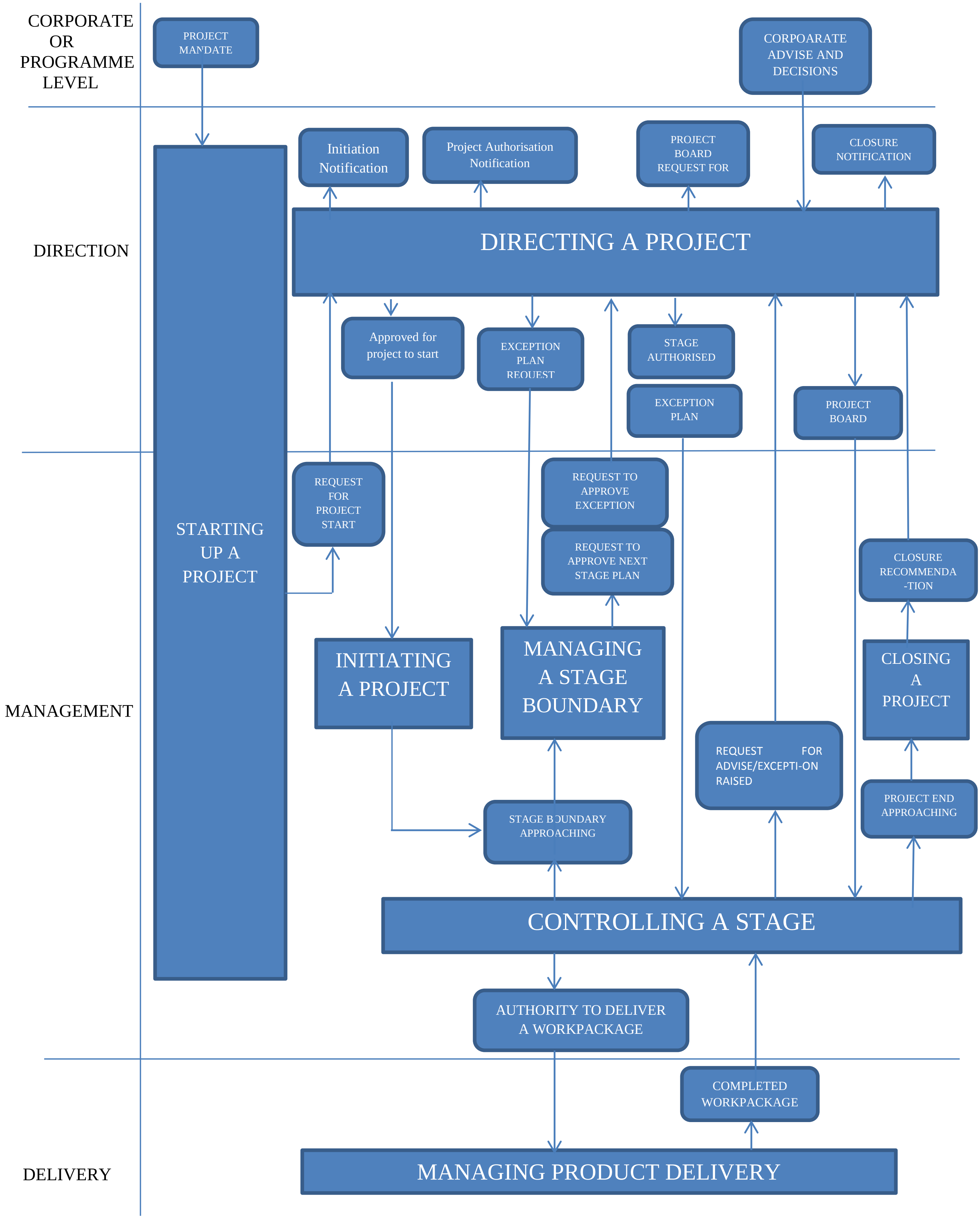


Figure 34: PRINCE2 Project Model (Murray et al., 2009)


CORPORATE OR PROGRAMME LEVEL
PROJECT MANDATE
CORPOARATE ADVISE AND DECISIONS
DIRECTION
Initiation Notification
Project Authorisation Notification
PROJECT BOARD REQUEST FOR
CLOSURE NOTIFICATION
DIRECTING A PROJECT
Approved for project to start
EXCEPTION PLAN REQUEST
STAGE AUTHORISED
EXCEPTION PLAN
PROJECT BOARD
MANAGEMENT
STARTING UP A PROJECT
REQUEST FOR PROJECT START
REQUEST TO APPROVE EXCEPTION
REQUEST TO APPROVE NEXT STAGE PLAN
CLOSURE RECOMMENDA -TION
INITIATING A PROJECT
MANAGING A STAGE BOUNDARY
CLOSING A PROJECT
REQUEST FOR ADVISE/EXCEPTI-ON RAISED
PROJECT END APPROACHING
STAGE BOUNDARY APPROACHING
CONTROLLING A STAGE
AUTHORITY TO DELIVER A WORKPACKAGE
COMPLETED WORKPACKAGE
DELIVERY
MANAGING PRODUCT DELIVERY

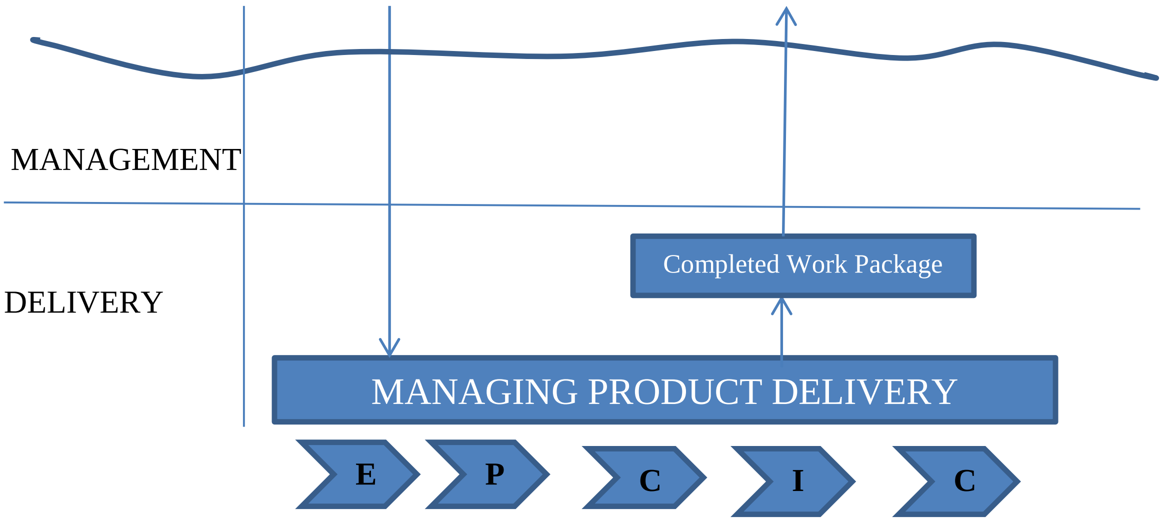
2.8 Integrating the EPCIC Model under PRINCE2

In a EPCIC model we are looking at delivering various work packages (like FPSO , vessel, turret and mooring system compressors, turbines, subsea equipment, propulsion, lifting cranes, fire & gas systems etc.) . In each lifecycle phase managing product delivery through PRINCE2 model will be effective in capturing deviations and getting it approved.

PRINCE2 model helps in managing issues through escalation & exception. This would thus help in capturing issues early associated with various work packages.

The PRINCE2 project model can thus be applied for managing these various work packages.

The EPCIC phases can be embedded into the PRINCE2 model as shown below.



2.9 PRINCE2 address decision gates

PRINCE2 addresses the decision gates element through the plans theme driven by manage by stage principle, with stage “gates” built in to the Directing a Project Progress.

The manage by stages principle requires that projects are planned, monitored and controlled on a stage-by-stage basis. Breaking a project into a number of management stages provides control points at major intervals for the senior management the project lifecycle (Murray et al., 2009). At the end of each stage, the project’s status shall be clearly assessed, the Business case and the plans shall be reviewed so as to ensure that the project still remains viable. Decision is then made as to whether to proceed to the next stage or stop at this stage.

I.e., if the market response falls within the business case parameters, then the investment decision is whether to fund the build phase. In case if the market response falls outside the business case parameters, e.g., the cost is higher than anticipated, the investment decision is whether to support an update to the business case to determine the ongoing viability of the project or, possibly, fund the project in any case.

The example investment decision gating framework is shown below

Table 2 Example Investment Decision Gating Framework (Ross, 2011)

Project Lifecycle	Strategic Assessment	Preliminary Assessment	Business case development	Procurement	Build	Service delivery
Key Project documents	Strategic business case	Preliminary Business case Concept design	Final business case Procurement Strategy Detailed design	Updated final business case Bid evaluation report	Contract Project completion report	Benefits realization plan Business case
Major milestones	Project established Project executive appointed Governance established	Advisors appointed	Procurement model decided Decision to approach market taken	Expression of interest issued Requests to tenders issued Contract award	Construction start Commission ing complete	Commence operational service Close project
Estimates and accuracy	No estimates or based on past projects ± 100%	Preliminary estimate based on concept design ± 50%	Pre-market estimate based on detailed design ±15%	Contract price ± variations	Actual outrun ±0%	
Investment Decision	Strategic decision to proceed	Funding to develop	Final business case;		Investment	decision
Gateway Process Gates		Business Justification GATE A	Delivery Strategy GATE B	Investment decision GATE C	Readiness for service GATE D	Operational Review GATE E

Chapter 3 Status quo of some International & NCS Projects

3.1 Review of International Projects

Like all Global Major oil Companies, Russian Oil Major spends spend billions of dollars each year on major projects. Higher Investments are needed to recover oil and gas from existing fileds, marginal fields, deep depth areas & remote area(s). These capital investments were estimated to be US$47 billion in 2013. However studies have indicated that many of these large capital projects are risky prone having significant cost overruns, delivery delay(s) etc. Few examples which were noteworthy mentioning were Australia's Chevron Gorgon natural gas project with cost overruns of 41 percent, Kazakhstan's of Caspian oil fields development projects witnessing overruns of 233 percent, Shell's Alaska offshore drilling project in the Arctic Ocean, which cost more than $3.1 billion (Kozinchenko, Mordovenko, Tideman, & Chehade).

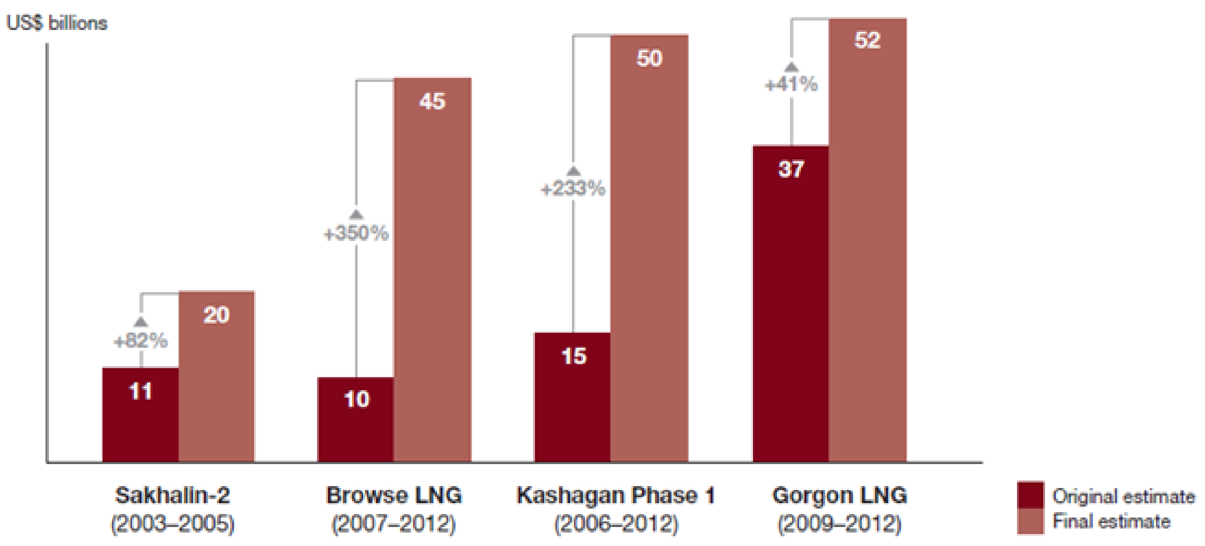


Figure 35: International Oil and Gas Projects cost overruns in recent years (Kozinchenko et al.)

The potential for savings generated by improving the efficiency of projects can be enormous. The rapid declines in the oil prices have enormously cut the margins on the numerous planned projects (some having virtually zero profits in current scenario). The EU & USA imposing of sanctions on Russia (due to its policy on Ukraine) have worsened the situations thus imposing threats for investments from EU nations, USA and some major Asian countries. For Russian Oil Companies to plan investments in large capital projects with few of these taking a span of 20 years for completion (Kozinchenko et al.).

Thus Russian oil and gas majors must focus on improving the efficiency of their multibillion dollar projects. Factors responsible for cost overruns and delays are shown below.

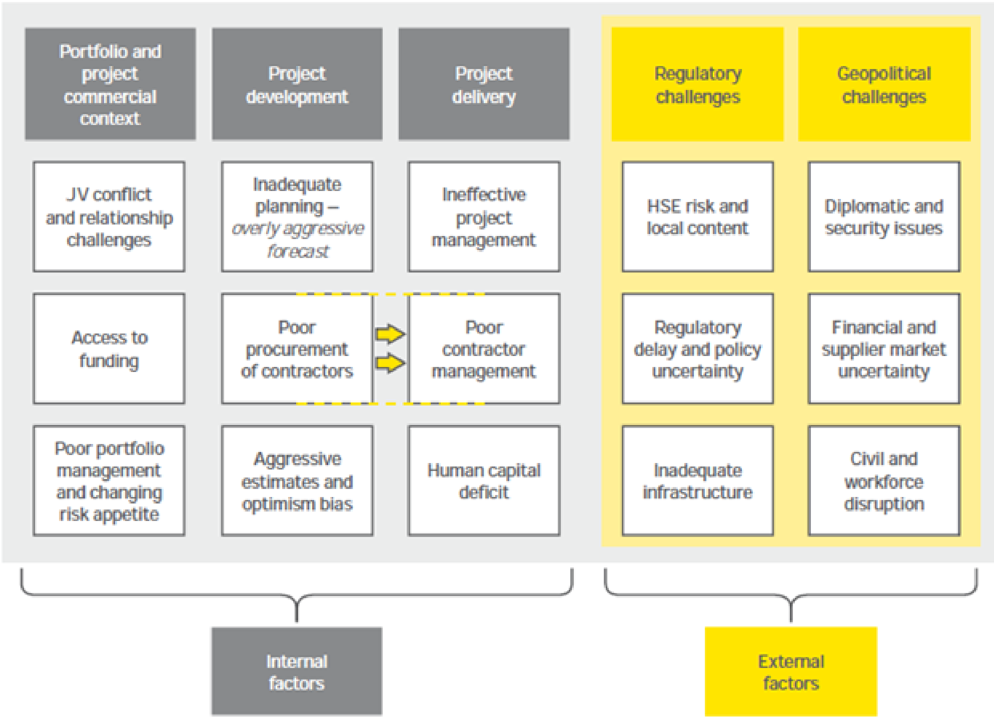


Figure 36: Factors responsible for cost overruns and delays (Young)

Key Reasons for Project Failures

Many projects fail due to two key primary reasons namely (Kozinchenko et al.)

1. Governance and Performance Management problems: Delineated responsibility for strategic and operational decision making at each stage of the project is a key challenges for many Russian Oil & Gas companies which have joint ventures with other global/governmental companies. The Kashagan project in Kazakhstan is a classic example of such governance problems. The partners in this project Shell, ENI, Total, ConocoPhillips, and the Kazakhstan government, each of these have their own management procedures and audit procedures. Thus it makes it very difficult to get agreement on critical plans and procedures. Companies struggle to maintain efficient cross-functional interactions.

2. Process problems: Improving the efficiency of planning and implementation processes can save billions of dollars for companies in large capital projects. Front end planning is the key success to any project. Numerous project failure cases have shown examples of projects where inadequate detail planning (due to pressure from shareholders to push the project) has led to errors in the calculation of business cases and to poor planning.

Overoptimistic estimates of time, budget, and technical capabilities etc. by companies to get approval from investment committees' results in significant losses.

Inefficient operational processes could hamper project success. For example during the analysis of Chevron's Gorgon project it was identified that ships carrying essential equipment idled in ports for several days due to a lack of space to unload them incurring losses of $500,000 a day (Kozinchenko et al.)

Another example tells of a Russian company that took 21 days to approve the procurement of equipment (as against to the normal 3-5 days needed for best decision practicing companies).

Table 3: Project Overruns Causes (Kozinchenko et al.)

Governance and Performance Management problems	Planning and implementation process problems
-Lack of clear centers for strategic and operational decision making	-Poor Project prioritization
-Lack of analytical support for decision making	-Inefficient operating processes specifically in logistics and procurement
Inefficient cross functional interactions	Lack of control over day to day expenditures Inefficient planning and approval processes

Reasons why cost estimates can go wrong:

Some of the major factors that impact the cost are given below:

- Scope changes due to poor definition in early phases
- Incomplete/inefficient Engineering, lack of rigor in gated process
- Poor Project to Operations "communication" and vice versa
- Under-estimation of the time schedule e.g. drilling a well, laying pipe lines etc. Schedule delays can cause large cost increases due to the high cost of specialist installation and commissioning personnel and equipment
- Poor risk management, having lack of contingency plans, no proper contractual protection between operator and vendors
- Poor communication, ineffective interface management, inadequate project management
- Confusing accuracy with confidence as information increases. Ignoring dependencies and inter-dependencies

3.2 Review of projects on the Norwegian Continental Shelf

The Figure below from NPD depicts the costs incurred on the Norwegian Continental Shelf

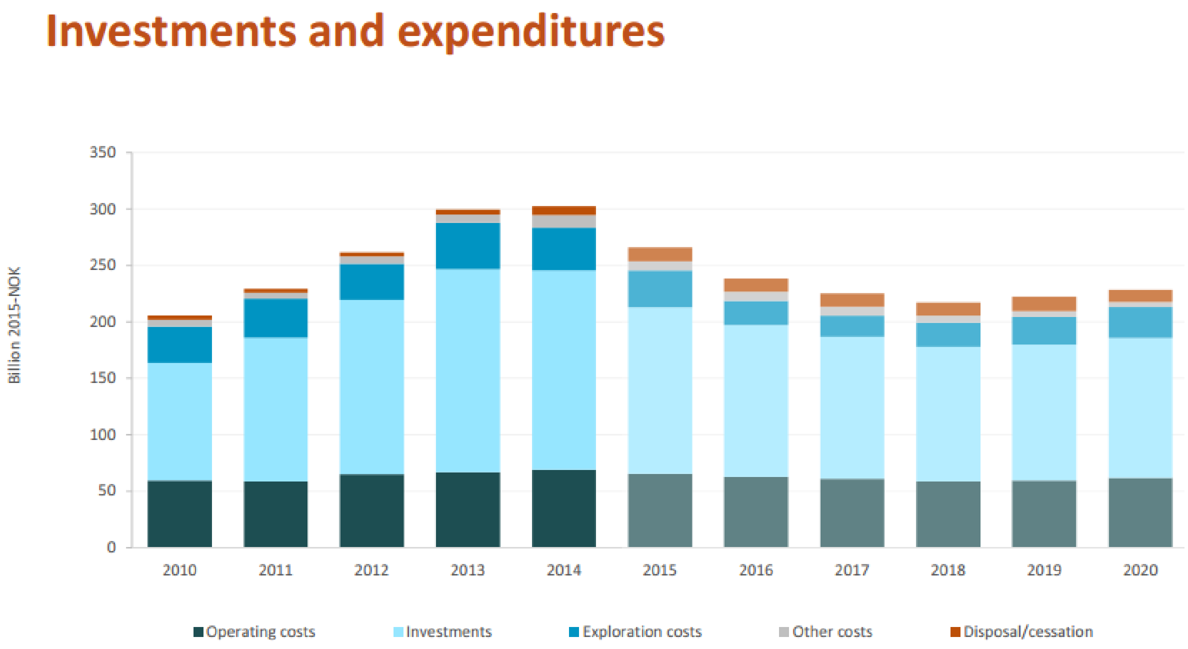


Figure 37: NPD depicts the costs incurred on the Norwegian Continental Shelf (NPD, 2013)

In 2013 , NPD (Norwegian Petroleum Directorate) has done a post project analysis on few major Offshore multimillion projects and has seen that some projects had major cost overruns, implementation times etc. The post project analysis was done to understand the reasons why few projects have failed to deliver on time, costs & quality over to the initial estimates given in the plan for development and operation (PDO). This analysis serves to highlight lessons learnt/experience transfer to other ongoing projects. These costs overruns are not unique for the NCS as recent studies reveal major international projects which suffer both with regard to costs and implementation time.

It was identified that a thorough, high quality work in the early phase (FEED stage) is crucial for the project success on later stages. In this study it was found that few projects have not a solid FEED study performed before proceeding to the next stages which in thus attributed for the project delay (ex: had effect on stages such as construction & procurement) .

New information not being taken during FEED , operators lacking an internal decision programme, unclear quality requirements prior to project sanctioning etc. are few examples of the drivers that have attributed to project failure(in terms of schedule, costs & quality)(NPD, 2013).

The table below shows the estimates of few projects presented in 2013 Norway Parliament budget sessions.

Table 4: Field with Cost changes according to NPD (NPD, 2013)

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

The Skarv, Yme and Goliath projects have experienced considerable overruns in both costs and implementation time.

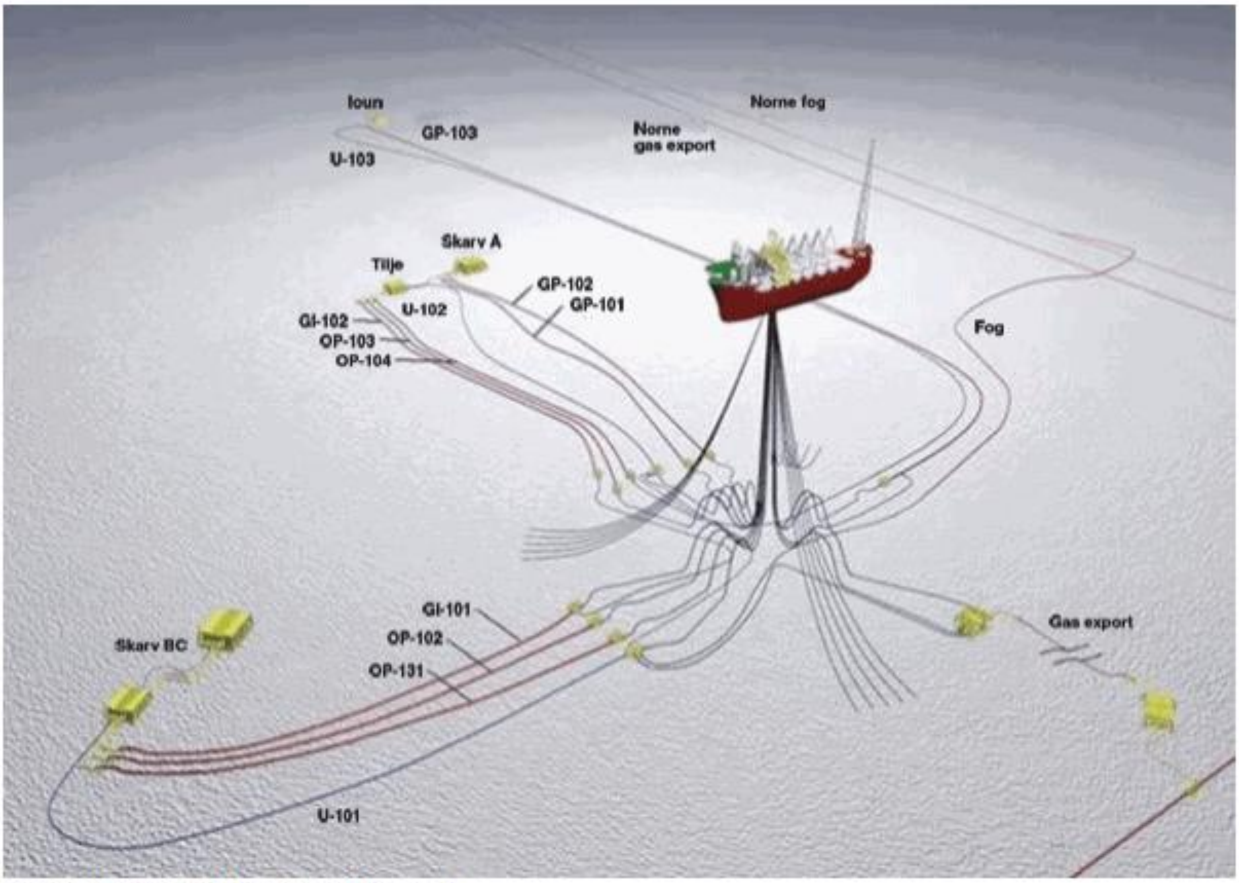
We shall review the Skarv & Yme Projects and study the failures that had promoted the cost/schedule overruns. The following study below is obtained from the report “Evaluation of Projects Implemented on the Norwegian Continental Shelf” made by NPD in 2013. A detailed study of this report helps in identifying the potential project mishaps.

3.2.1 Project review of Skarv

Brief Description of Skarv Project

Skarv is located in production licenses PL159, PL212, PL212B and PL262 and is situated about halfway between Norne and Heidrun in the Norwegian Sea. It was discovered in 1998 and operation started in late 2012/ early 2013 with a field life of 25 years. Recoverable reserves have been estimated at 43.4 GSm³ gas and 15.5 MSm³ oil and 5.6 mill. tonnes NGL. Nearly 80% of the recoverable resources on Skarv are gas and the remaining 20% are liquids.

Skarv is a production vessel with storage and offloading capacity (FPSO). It is anchored to the seabed and has one of the world's largest gas processing plants offshore. It is a subsea layout with 5 subsea templates tied to the FPSO and will produce through in all 16 wells. Gas reinjection is used for pressure support. The produced oil is loaded to tanker ships and the produced gas is transported via an 80 km pipeline to Åsgard Transport and the gas is sent to processing at Kårstø in Rogaland, Norway. According to the plan submitted to the PDO Skarv field will have 16 wells, 7 oil producers, 5 gas producers and 4 gas injectors (NPD, 2013).



Skarv field development layout.

Figure 38: SKARV FIELD (BP, 2007)

Statoil AS, Dea E & P Norway AS, BP Norway AS & PGNiG Upstream International AS are the licensees on the SKARV Field.

Field Development - Contracts

The SKARV development was approved by Norwegian Parliament in 2007. The SKARV development consists of 2 main elements:

- Drilling of the wells, this includes leasing a rig for drilling
- Facilities like Production facility, subsea equipment, pipelines, umbilical's, and gas export lines etc.

FEED, detail engineering and procurement, covering the vessel's topsides were carried out by Aker Solutions. Fabrication and installation of the hull and topsides were carried out by Samsung Heavy Industries, South Korea. SBM Offshore designed the turret and mooring system and was built at the Keppel Shipyard in Singapore. GE Vetco carried out the engineering, construction and testing of wellheads and tree systems, subsea templates, tie-in intervention and workover systems. Flowline installation, design, manufacturing, Installation of subsea structures, control umbilical's, dynamic umbilical and flexible risers were done by Subsea 7. Skarv has been producing since the turn of the year 2012/2013 (NPD, 2013).

Cost Changes

It was observed that there was a major cost increase over original estimate and late start –up of the field operations.
Cost development for the Skarv project from PDO to completion

Table 5: Cost changes in SKARV (NPD, 2013)

	MNOK (2012) PDO	MNOK (2012) Completion (June 2013)	% change
Project Management Team/ Owners' costs	4 987	6 509	31%
Engineering, procurement & Construction management	1 412	1 779	26%
FPSO Hull & Living Quarters, Marine operations	3 772	3 485	-8%
FPSO Topsides Fabrication, Integration, Control system & Major Equipment	6 438	9 994	55%
Turret & Mooring System	2 289	2 765	21%
SURF (Subsea Production System, Umbilical's, Risers & Flowlines)	7 391	10 882	47%
Gas Export Pipeline	2 101	1 721	-18%
Drilling & Completions	6 651	9 248	39%
Total	35 038	46 379	32%

Even though the drilling of the production wells have started from 2010 and FPSO is ready by 2011 the field production didn't turn up till 2013 due to various reasons.

The overrun cost is estimated at over NOK 11 billion ($1.8 billion) on the original budget of NOK 35 billion.

Root Causes for Project Delay

The following are the some of the causes for the project delay.

- Extended Mechanical Completion (Yard Stay): The FPSO was made in South Korea and delivered in 2011 to Norway. One month is set aside for mechanical completion of the FPSO at Stord before it is sent to the sea. However when the FPSO arrived in Stord several leaks were discovered in the turret that needed to be repaired. This has caused the FPSO stay at Stord extended to five months than originally planned. Deficient follow-up of the turret construction at Singapore by the ECPCI contractor is attributed for the overruns in this scenario.

- Misunderstanding of Norwegian working environment requirements: During the construction phase of the FPSO greater challenges were faced by operator in understanding of Norwegian working environment requirements. This was not sufficiently focused by neither the supplier nor operator in the early phase of construction. Major faults and deficiencies were thus discovered at a later stages in the projects which became a really challenge and cost-intensive to comply with requirements. Miscalculation in the operator's early estimates regarding to use of overtime in Norwegian Working Environment Act, have become cost intensive (personnel intensive) than originally assumed in the PDO.

- Weather conditions: Since there was a substantial delay in the yard Stay of the vessel , the risers weren't installed as planned for the initial soft north sea weather condition (good weather periods for installation works) . The rough weather related problems (such as high waves) couldn't facilitate the installation of the risers as planned, thus postponing the commissioning of the FPSO vessel by over a year to December 2012. The specialized vessels commissioned to install the risers were now decided to hold back until good weather conditions have turned up. Having specialized vessels remaining idle on location is costly.

- Engineering delays: Cost overruns and delays can be attributed to the hasty decision making by project management personnel. Due to long delivery times, several equipment packages were ordered prior to the engineering have been completed by sub vendors. These variations had a severe dent on the project money & time.

- Escalated Drilling Costs: The operator had made estimates (submitted in the PDO) for the drilling rates based on his experience with a regular customer (rig supplier). It was not during a later stage in the project it was found that delivering the rig as per the planned schedule is extremely difficult from supplier side. Thus the operator had cancelled the rig contractor with the current supplier and had signed a new contract with another supplier who assured him that the wells would be drilled on time. However this new contract was thrice more expensive than the original quoted ones which led to increasing drilling costs.

Lessons Learnt:

The lessons learnt on the SKARV Field are:

Delivery of critical equipment: As mentioned earlier the operator (BP and its licensees) have experienced serious troubles with delivery of the equipment both in terms of time, cost(s) and quality. The operator should have at least identified the critical equipment packages and should have handled/followed this with the sub vendors (equipment manufacturers) themselves (exclude these form the main contract) instead of assigning the responsibility to the contractor (Aker Solutions) in the very beginning of writing the contract. This would have helped to have critical packages to be delivered as per the schedule.

Efficient Quality control: Major delays and cost overruns have been attributed to deficient vessels. Quality control of the vessels prior to entering into the installation contracts and prequalification of the companies would aid in achieving the deliveries on time & costs.

Involvement of personnel: Involvement of offshore in all phases of project is good for a project success. Unfortunately the operational personnel haven't been involved during the construction phase of the project resulted in some cases of additional work and cost increases.

Supplier commitment failures: Due to the failure from suppliers to meet the promised deliveries, at a time during the project the contracts were cancelled and new contracts with earlier promised suppliers were granted. This had increased costs and delays. However this was a good initiative taken because if not this decision taken the project delay & costs were be much more than the current ones.

Change Order Management: There were lots of change orders (variations) submitted by the contractor during the construction of the platform. Highly knowledgeable commercial team have handled this very efficiently to drive the costs a bit down during the early project phases.

Another lesson is that the accommodation needs in connection with offshore hook-up and completion should have been taken into consideration to a greater extent when the final bed capacity at the ship (FPSO) was determined.

3.2.2 Project review of Yme

Brief Description of Yme Project

The Yme field is located in the eastern part of Norway (Egersund Basin) at a water depth of 93m. Yme was originally developed with a jack-up production platform on Yme Gamma and a storage vessel. The Beta structure was developed with subsea wells. Production started in 1996.Yme was operated by Statoil up to 2001 when production ceased. Talisman is the operator of the field. The field was produced mostly by pressure depletion, and Partly by water flooding, gas lift and down hole pumps (NPD, 2013).

The Yme PDO called for a development with 12 wells – seven producers and five injectors. The recoverable reserves are 14.1 million Sm3 oil. Planned production start was in February 2009.

The figure below from Talisman homepage shows a brief history of Yme field

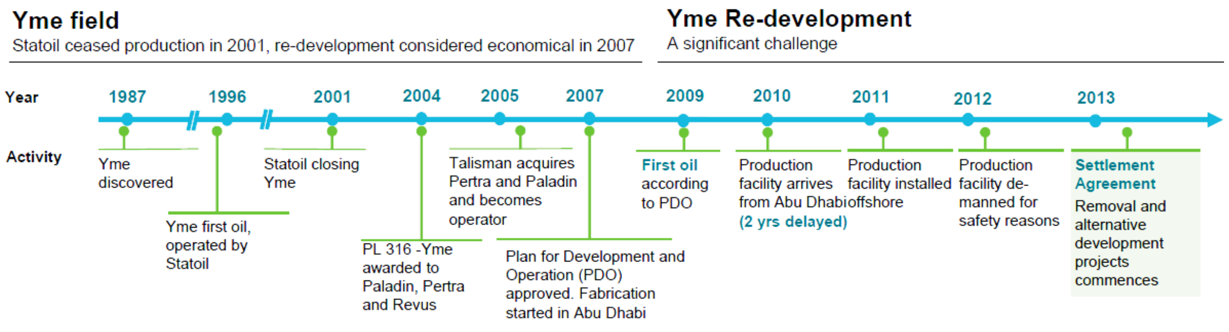


Figure 39: YME Field Time Plan (Vidar, 2013)

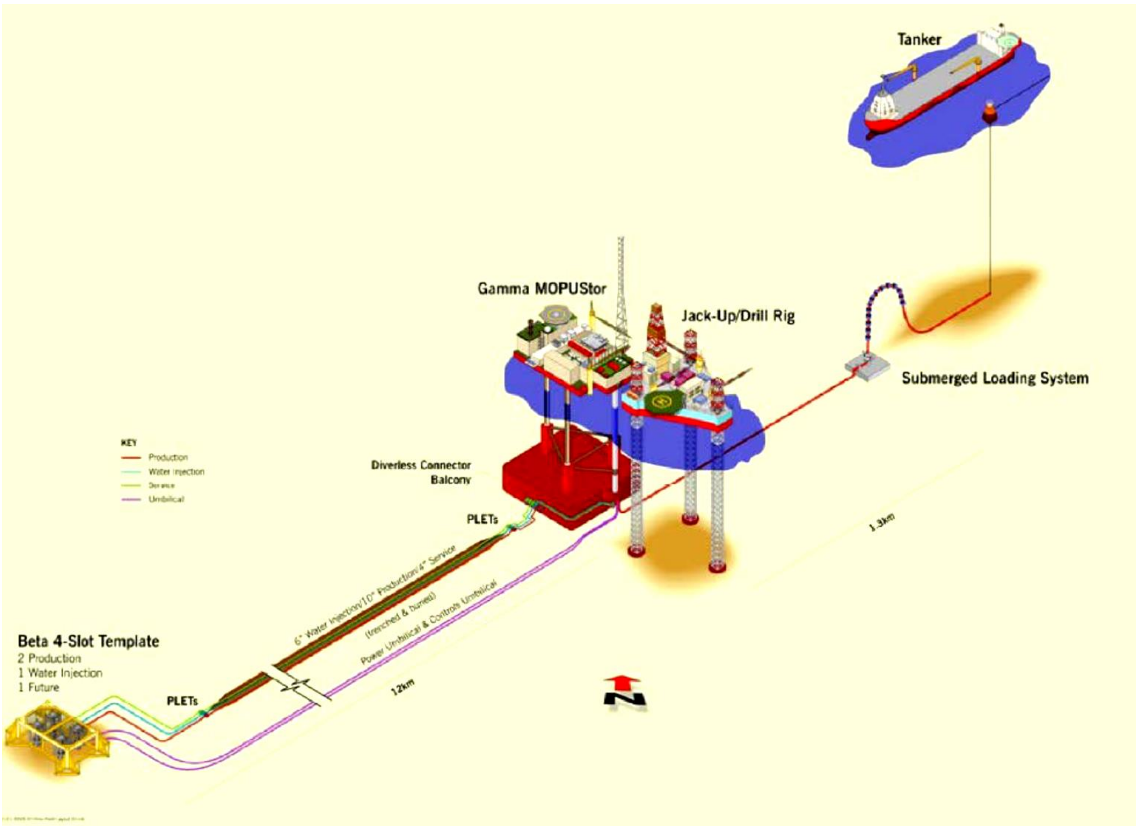


Figure 40: YME Field Layout (Vidar, 2013)

Licensees: Talisman Energy AS (60 % share), Lotos Exploration and Production AS (20%), Wintershall Norge AS (10%) and Norske AEDC A/S (10%)

Field Development – Contracts

The Yme re-development was approved by Norwegian Parliament in May 2007. This consists of 3 main elements:

- Drilling of the wells, both production and induction
- Facilities like Production facility, subsea equipment, pipelines, umbilical's, gas export lines etc.
- Construction of a mobile production unit (MOPU) with a storage tank

For the MOPU Yme licensees have entered into an EPCI contract agreement with Single Buoy Moorings Inc (SBM)

The storage tank and the subsea layouts (umbilical's, subsea production facility, pipelines etc) were installed in 2008 as per the schedule. However the MODU was installed offshore 3 years later (in summer 2011) than to the agreed plan approved by PDO. Later in later 2012 several structural faults were identified in MODU thus a decision was taken to scrap the MODU. Based on this the licencees have applied to Ministry of Petroleum and Energy to grant approvals in order to replace the MOPU with an alternative production facility (NPD, 2013).

Figure 41: YME MOPU near sail away from Abu Dhabi (Vidar, 2013)

Figure 42: Yme MOPU Installation – July 2011 (Vidar, 2013)

Cost changes

Table 6: Cost development for the Yme project from PDO to cessation (NPD, 2013)

	MNOK (2012) PDO	MNOK (2012) Completion (June 2013)	% change
Wells	3076	4299	40%
Subsea facility	1159	1350	17%
Mobilisation and insuring facilities	209	3595	1620%
Project management	450	2315	414%
Total	35 038	46 379	136%

Root causes for project delay

1. Though drilling/completion of subsea wells were under cost& schedule the major steal shower for the project failure is the MODU. Also there were certain miscalculations about the profitability of the project while submitting it to the PDO.
2. The operator who took this project had no experience working on the Norwegian Continental shelf though he had little experience on the UK continental shelf. The operator had poor understanding of the NCS quality requirements. The operator chose a leasing concept (a lump sum EPCIC contract) had a fatal blow to the project
3. The contractor SBM lacked experience in implementing major construction projects according to Norwegian requirements. This supplier risks were not considered as critical by the operator which led to the delay in MODU delivery
4. Insufficient time allocated for the FEED and detail engineering prior to fabrication is another serious blow to the YMe Project. Also the fabrication and procurement were

initiated far too early before the completion of detail engineering. This inappropriate planning caused schedule delays and cost overruns.

5. Before the submission of the project to PDO, the operator identified that supplier had problems understanding Norwegian regulations and NORSOK standards. Also the contract form chosen gave little importance to supplier follow-up during construction of the platform at Abu Dabhi. It was not till more non-conformities were identified that the operator started sending many personnel from Norway to follow-up the project, thereby cumulating to more cost (costs for follow-up). Also when the MODU reached Rosenberg, it was decided to send the platform offshore so as to meet the planned offshore dates, in spite of identifying huge non-conformities here in Rosenberg. It was planned to close the nonconformities while MODU in on offshore which escalated the costs for fixing the faults on the sea. It was not many days it took to identify structural flaws and cracks in the foundation that fastened the MOPU legs to the storage tank , thus the MOPU was decided to be scrapped(NPD, 2013)

Lessons learnt

The following are some of the important lessons learned from the failure of Yme Project

1. Insufficient time for FEED
The failure is attributed as to not having a qualified internal system for monitoring before decision is taken to sanction the project. Insufficient time to complete the FEED, partly finished detail engineering and inappropriate judgment of suppliers expertise in areas such as quality, delivery & experience have attributed to the project failure.
2. Another failure reason is the inefficient usage of the EPCIC lease contract form. Had the operator been the owner of the facility (MOPU), it should have been sold/rented out after construction (than having a whole period of waiting time escalating costs) and then leased back in for the operations phase.
3. Less focus on project follow-up and inefficient expertise of follow-up personnel is another reason adding to the project failure.

3.3 Lessons learnt from failed offshore Projects (Gjøa, Tyrihans, Valhall):

A thorough review of the Report made by NPD (NPD, 2013)highlights the major lessons learnt that need to be considered in new offshore projects.

1. Taking the right decisions at the right time helps projects to succeed. A sufficient basis for making these decisions plays the crucial factor. Involving right personnel (from various disciplines) throughout the project phases will help to achieve this.
2. A dedicated follow-up team with the correct expertise (having extensive knowledge of Norwegian regulations and standards) at the construction site helps to delivery the end product (platform, mechanical work packages such as Gas turbines, compressors etc.) at the right quality. Prequalification of relevant suppliers for the project was a key activity in order to succeed. Thorough prequalification of the suppliers (in terms of previous experience like quality, delivery security, financial strength, etc.) could mitigate the risks further down and also reduces need for follow-up.

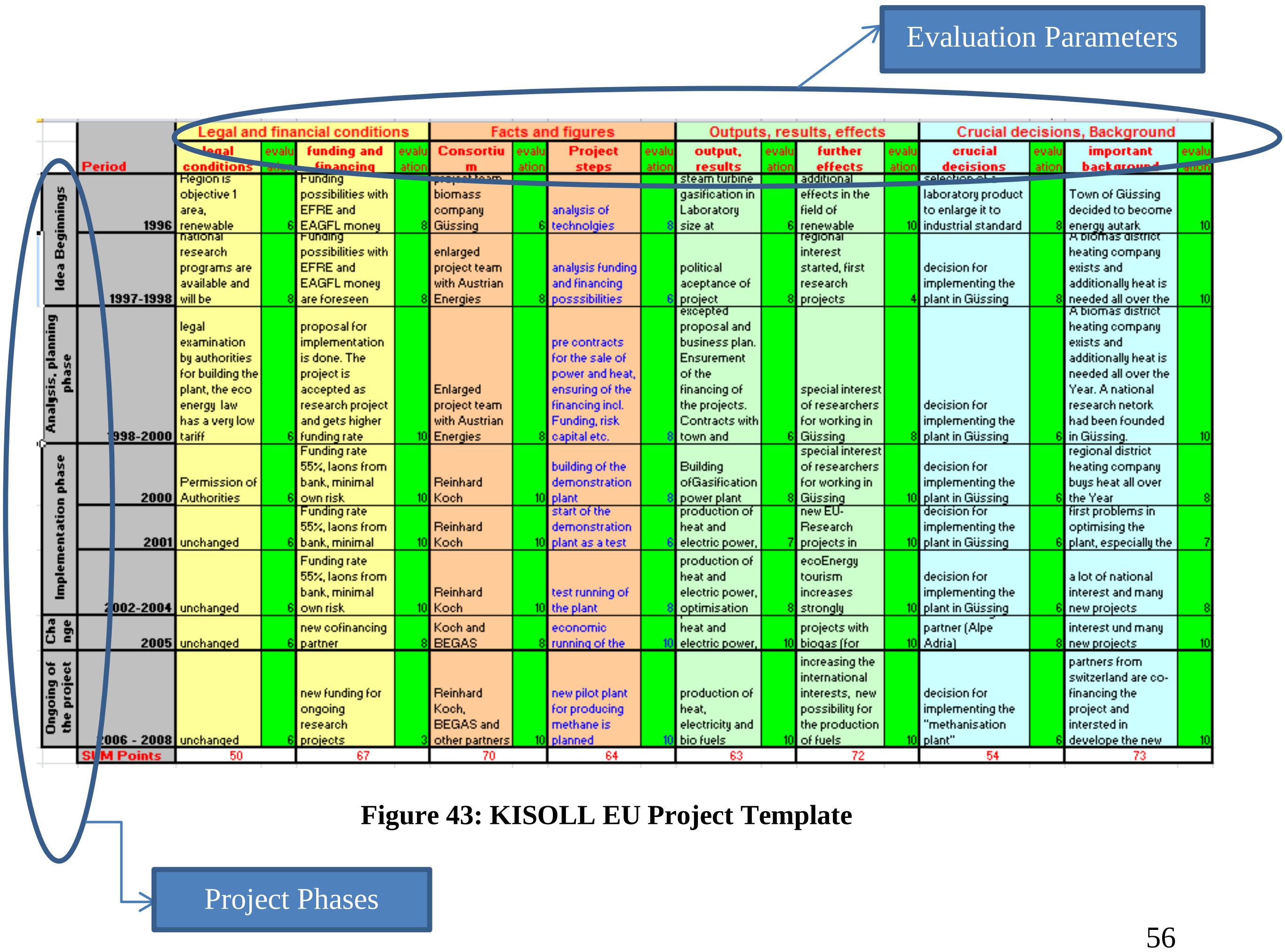
3. Qualification of new technology was identified early on as one of the largest risks in many offshore project. Understanding the scope of work in the project is another key for project delays.
4. Direct supervision of critical work packages should be done by the operators to avoid schedule delays.
5. Choosing effective contract strategies help to mitigate the risks of schedule/cost delays. For many projects on the NCS design and build contracts have resulted in significant cost and times savings
6. Complete FEEED before going to PDO approval is mandatory for project success. Experience shows that projects with deficient early phase work have experienced significant changes during construction phase resulting in major overruns and delays.
7. Estimates submitted to PDO shall be realistic with enough tolerances set-up. Exaggerated optimism, unrealistic ambitions, deficient understanding of the uncertainty should be carefully studied before submitting the projects to PDO approval. Insufficient detailed planning of the drilling and completion operations when preparing the PDO should be looked at in detail.

Chapter 4 Methodology

4.1 Starting point for the development of the needed "Project Evaluation Template"

Cluster on Industrial Asset Management (CIAM) – Project Engineering and Management (PEM) Hub is currently working on a project called "Cross Functional Excellence in Project Management". The Hub team members are developing a project evaluation template using an existing old project evaluation template developed for KISOLL EU Project, through a series of brain storming sessions/discussion meetings.

The below is the Project template made for KISOLL EU Project. We shall be using this template as a reference for the desired "Project Evaluation Template" for the offshore EPCIC model.



		Legal and financial conditions				Facts and figures				Outputs, results, effects				Crucial decisions, Background			
	Period	legal conditions	evaluation	funding and financing	evaluation	Consortium	evaluation	Project steps	evaluation	output, results	evaluation	further effects	evaluation	crucial decisions	evaluation	important background	evaluation
Idea Beginnings	1996	Region is objective 1 area, renewable	6	Funding possibilities with EFRE and EAGFL money	8	biomass company Güssing	6	analysis of technolgies	8	steam turbine gasification in Laboratory size at	6	additional effects in the field of renewable	10	laboratory product to enlarge it to industrial standard	8	Town of Güssing decided to become energy autark	10
	1997-1998	national research programs are available and will be	8	Funding possibilities with EFRE and EAGFL money are foreseen	8	enlarged project team with Austrian Energies	8	analysis funding and financing posssibilities	6	political aceptance of project	8	regional interest started, first research projects	4	decision for implementing the plant in Güssing	8	A biomas district heating company exists and additionally heat is needed all over the	10
Analysis, planning phase	1998-2000	legal examination by authorities for building the plant, the eco energy law has a very low tariff	6	proposal for implementation is done. The project is accepted as research project and gets higher funding rate	10	Enlarged project team with Austrian Energies	8	pre contracts for the sale of power and heat, ensuring of the financing incl. Funding, risk capital etc.	8	excepted proposal and business plan. Ensurement of the financing of the projects. Contracts with town and	6	special interest of researchers for working in Güssing	8	decision for implementing the plant in Güssing	6	A biomas district heating company exists and additionally heat is needed all over the Year. A national research netork had been founded in Güssing.	10
Implementation phase	2000	Permission of Authorities	6	Funding rate 55%, laons from bank, minimal own risk	10	Reinhard Koch	10	building of the demonstration plant	8	Building ofGasification power plant	8	special interest of researchers for working in Güssing	10	decision for implementing the plant in Güssing	6	regional district heating company buys heat all over the Year	8
	2001	unchanged	6	Funding rate 55%, laons from bank, minimal	10	Reinhard Koch	10	start of the demonstration plant as a test	6	production of heat and electric power,	7	new EU-Research projects in	10	decision for implementing the plant in Güssing	6	first problems in optimising the plant, especially the	7
	2002-2004	unchanged	6	Funding rate 55%, laons from bank, minimal own risk	10	Reinhard Koch	10	test running of the plant	8	production of heat and electric power, optimisation	8	ecoEnergy tourism increases strongly	10	decision for implementing the plant in Güssing	6	a lot of national interest and many new projects	8
Change	2005	unchanged	6	new cofinancing partner	8	Koch and BEGAS	8	economic running of the	10	heat and electric power,	10	projects with biogas (for	10	partner (Alpe Adria)	8	interest und many new projects	10
Ongoing of the project	2006 - 2008	unchanged	6	new funding for ongoing research projects	3	Reinhard Koch, BEGAS and other partners	10	new pilot plant for producing methane is planned	10	production of heat, electricity and bio fuels	10	increasing the international interests, new possibility for the production of fuels	10	decision for implementing the "methanisation plant"	6	partners from switzerland are co-financing the project and intersted in develope the new	10
	SUM Points	50		67		70		64		63		72		54		73	

Figure 43: KISOLL EU Project Template

The different project phases and evaluation parameters for KISOLL EU Project are shown above.

CIAM-PEM Hub has used the KISOLL EU Project template and modified the template shown below

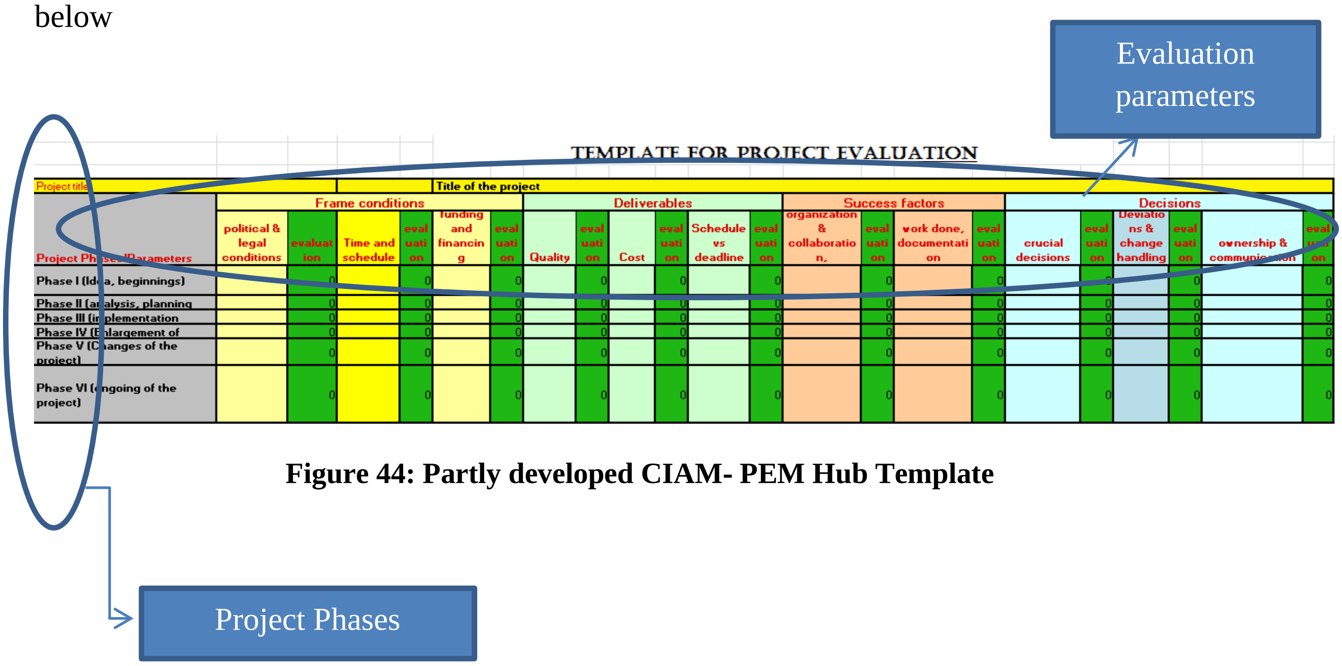


Figure 44: Partly developed CIAM- PEM Hub Template

4.2 Identification of Project Phases for the needed "Project Evaluation Template"

As shown above the KISOLL EU Project template splits the project into number of phases namely Idea Beginnings, Analysis/planning phase, Implementation phase, Change & Ongoing of the project.

We need to alter the above phases to suit the EPCIC project model. Through a detailed literature review in Chapter 2 lifecycle for the project are divided into the phases below

1. Phase I (Feasibility /Concept Selection/Concept Development / FEED)
2. Phase II (Engineering)
3. Phase III (Procurement)
4. Phase IV (Construction)
5. Phase V (Installation)
6. Phase VI (Commissioning & Hookup)
7. Phase VII (Project Closure)

Phase I (Feasibility /Concept Selection/Concept Development / FEED): The phase can be divided into feasibility studies *(concept screening*, *conceptual engineering* and *concept selection)*, and pre-engineering. The main purpose of the phase is to identify all possible offshore field development concepts , confirm technical feasibility of considered development concepts .determine whether a business concept is technically feasible, , whether the associated uncertainties are manageable, whether it satisfies regulatory requirements, whether it is sufficiently profitable and choose the optimal one for an offshore field development. This is the most important phase which needs careful attention. Many projects fail due to bad concept selection. Wrong concept selection at the early project phase could lead to project failure (in terms of costs, time etc.).

Classic example to this as identified in Chapter 3 is the Yme platform which was a bad concept selection. The concept selected is found not be appropriate for operation mainly on the NCS.

Phase II (Engineering): The engineering phase is the detail engineering of various equipment packages like Structural, Process, Instrumentation & telecommunications, Electrical, Mechanical, Piping layout etc.

Phase III (Procurement): This phase consists of procuring the equipment packages (like turbines, subsea equipment, compressors, processing systems, lifting cranes, fire & gas systems etc.), materials ordered early such as long lead items, services etc.

Phase IV (Construction): The Input from front-end engineering through detailed design to have deliverables constructed in the field and is made ready for installation in this phase.

Phase V (Installation): This phase involves installation of the procured work packages (like FPSO, risers, subsea templates etc.)

Phase VI (Commissioning & Hookup): Commissioning & Start-Up is the last visible step of a project execution process. It moves the project from the "end of construction" to the "commercial operation" status. This phase covers initial and primary dynamic tests, including guarantee performance tests.

Initiated right from the beginning of design phase, Commissioning & Start-Up activity aims to validate the construction integrity and confirms that the facilities are delivered in a safe, reliable and operational condition for a complete customer satisfaction.

Phase VII (Project Closure): This the final phase for the project which ensures all deliverables are made according to the contract, stakeholder satisfaction etc.

4.3 Identification of Critical Parameters to be monitored in each Project Phases

As shown above the various evaluation parameters used in the KISOLL EU Project template are Legal and financial conditions, facts & figures, outputs/results & effects, crucial decision/background.

We need to alter the above evaluation parameters to reflect the critical evaluation parameters that needs to be monitored across each phases (EPCIC). On the basis of wide literature survey that was described in the Chapter 2 & through the study of various projects on the NCS in

Chapter 3 the following ten parameters are identified as critical to be keenly monitored in each phase.

1. Regulatory requirements:
2. Costs
3. Quality
4. Readiness of Technology & competence
5. Project Risks
6. Schedule vs dead line (Progress)
7. Deviations & Change Management
8. Safety & Working environment regulations
9. crucial decisions, uncertainty
10. communication & interface management (stakeholder appraisal & ownership)

Thus our project evaluation template looks as shown below:

Project Phases/Critical Evaluation Parameters	Regulatory requirements	Costs	Quality	Readiness of Technology & competence	Project Risks	Schedule vs dead line (Progress)	Deviations & Change Management	Safety & Working environment regulations	crucial decisions, uncertainty	communication & interface management (stakeholder appraisal & ownership)
Phase I (Concept Selection/Planning/Concept Development/Feasibility study/										
Phase II (Engineering)										
Phase III (Procurement)										
Phase IV (Construction)										
Phase V (Installation)										
Phase VI (Commissioning & Hookup)										
Phase VII (Project Closure)										

<u>Development of critical parameters needs across each phases</u>

Now the template being partly made, we shall define the critical parameter needs in each phase.

This is achieved through the study of various projects discussed in Chapter 3 & through study of regulations such as PSA and through a series of brain storming sessions with some industry experts.

The critical parameter needs (1A, 1B, 1C, ……7I, 7J) is shown in **Appendix-A**

Thus our project evaluation template is now refined to below

		A	B	C	D	E	F	G	H	I	J
	Project Phases/Critical Evaluation Parameters	Regulatory requirements	Costs	Quality	Readiness of Technology & competence	Project Risks	Schedule vs dead line (Progress)	Deviations & Change Management	Safety & Working environment regulations	crucial decisions, uncertainty	communication & interface management (stakeholder appraisal &
1	Phase I (Concept Selection/Planning/Concept Development/Feasibility study/ FEED)	1A	1B	1C	1D	1E	1F	1G	1H	1I	1J
2	Phase II (Engineering)	2A	2B	2C	2D	2E	2F	2G	2H	2I	2J
3	Phase III (Procurement)	3A	3B	3C	3D	3E	3F	3G	3H	3I	3J
4	Phase IV (Construction)	4A	4B	4C	4D	4E	4F	4G	4H	4I	4J
5	Phase V (Installation)	5A	5B	5C	5D	5E	5F	5G	5H	5I	5J
6	Phase VI (Commissioning & Hookup)	6A	6B	6C	6D	6E	6F	6G	6H	6I	6J
7	Phase VII (Project Closure)	7A	7B	7C	7D	7E	7F	7G	7H	7I	7J

4.4 Introduction of STAGE GATES in the template

As discussed in Chapter 2.6 about the usage of Stage GATES (for monitoring & control) , we shall now introduce Stage GATES as shown below in our template

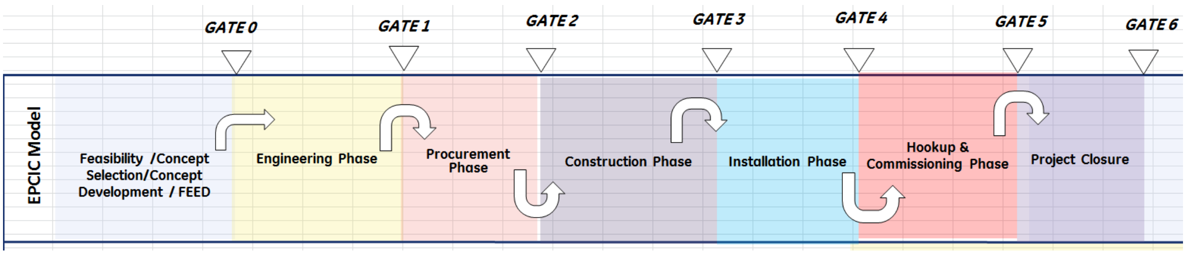


Figure 45: Introduction of Stage Gates in the Project Evaluation Template

Stage GATES encompasses as series of hold points & check points which helps in identifying project deliverables at the end of the stages which thereby promote the overall the project success. These are identified from the literature review and through the study of failed offshore projects.

The following Stage GATES were introduced while moving from one phase to the next phase.

STAGE GATES:

1. GATE 0
2. GATE 1
3. GATE 2
4. GATE 3
5. GATE 4
6. GATE 5
7. GATE 6

See **Appendix B** for the Hold points & Check points in the respective GATES.

Thus our project evaluation template is now refined to below

		A	B	C	D	E	F	G	H	I	J
	Project Phases/Critical Evaluation Parameters	Regulatory requirements	Costs	Quality	Readiness of Technology & competence	Project Risks	Schedule vs dead line (Progress)	Deviations & Change Management	Safety & Working environment regulations	crucial decisions, uncertainty	communication & interface management (stakeholder appraisal &
1 GATE 0	Phase I (Concept Selection/Planning/Concept Development/Feasibility study/ FEED)	1A	1B	1C	1D	1E	1F	1G	1H	1I	1J
2 GATE 1	Phase II (Engineering)	2A	2B	2C	2D	2E	2F	2G	2H	2I	2J
3 GATE 2	Phase III (Procurement)	3A	3B	3C	3D	3E	3F	3G	3H	3I	3J
4 GATE 3	Phase IV (Construction)	4A	4B	4C	4D	4E	4F	4G	4H	4I	4J
5 GATE 4	Phase V (Installation)	5A	5B	5C	5D	5E	5F	5G	5H	5I	5J
6 GATE 5	Phase VI (Commissioning & Hookup)	6A	6B	6C	6D	6E	6F	6G	6H	6I	6J
7 GATE 6	Phase VII (Project Closure)	7A	7B	7C	7D	7E	7F	7G	7H	7I	7J

4. 5 Capturing issues & Escalating through PRINCE2 model

As explained in literature review Chapter 2.7, the PRINCE2 project model is an effective project management model that helps in capturing the issues, escalating to the top level.

The themes of PRINCE2 Business case, Organization, Quality, Plans, Risk , Change, Progress are in line with our critical evaluation parameters (Regulatory requirements, Costs, Quality, Readiness of Technology & competence, Project Risks, Schedule vs dead line (Progress), Deviations & Change Management , Safety & Working environment regulations, crucial decisions, uncertainty, ownership , communication & interface management).

Deviations found across the STAGE Gates can be managed through PRINCE2 model. Get the necessary approvals before proceeding to the next stage. Record the deviations and revisit these again. This helps in efficient tracking of the Project Stages.

Example: There were few risks identified at the end of a phase stage. These have to be registered in the risk logs and proceed to the next phase. These risks shall be revisited while continuing work in the next phase.

4. 6 Rating of critical parameters & Project phases

With template developed above with Stage GATES introduced, we shall now try to rate the critical parameters across each phase and also try to rate the project phases. This is shown below

4. 6.1 Rating of the critical parameters:

The rating of the critical parameters was performed by collecting the opinion from experts who have substantial amount of experience managing projects on the NCS.

Opinion of 3 people was considering while ranking the parameters.

Table 7: Expert Information

Personnel	Area of expertise	Years of Experience
Expert 1	Project Management	24
Expert 2	Project Management/Engineering	12
Expert 3	Project Management/Operational Expertise	20

First, the experts were asked to evaluate the critical parameters in different phases by the following scale:
1 - Not important at all, 2 -Slightly Important, 3 - Moderately Important, 4 - Very important, 5 - Absolutely Critical.

See **Appendix C** for rating of the critical parameters

4. 6.2 Ranking of the Project Phases:

After the phase is completed before proceeding to the next phase the completed phase is rated from a scale of A to E as below

A: Excellent B: Very Good C: Good D: Moderate E: Weak

The rating of phases is given assessing if all the requirements mentioned in the Stage GATES have been met. This gives an idea on how well we are proceeding with each Phase (which eventually determines the Project Success). As mentioned Deviations found across the STAGE Gates can be managed through PRINCE2 model.

Thus the following have been formulated which will be incorporated into the Project template

Table 8: Ranking of Project Phases

PROJECT PHASE	MINIMUM RANK
Planning/Feed	Minimum Rank should be B or above in this phase
Engineering	Minimum Rank should be B or above in this phase
Procurement	Minimum Rank should be B or above in this phase
Construction	Minimum Rank should be B or above in this phase
Installation	Minimum Rank should be B or above in this phase
Commissioning & Hook-up	Minimum Rank should be B or above in this phase
Project closure	Minimum Rank should be B or above in this phase

Note: Minimum rating is decided based on series of brain storming sessions. This ratings are opinion based and can vary.

4. 7 Project Evaluation Template

The final project evaluation template now consists of project phases, critical parameters, Stage Gates (with hold points & check points), ranking of the critical parameters & finally ranking of the phases.

See the final "Project Evaluation Template" for the offshore EPCIC Project model.

4.8 Visualization of the Project Parameters in different phases

The figures shown below gives a visualization of the various critical parameters in different project phases with respect to their ranking given.

1. Visualization of Regulatory Requirements

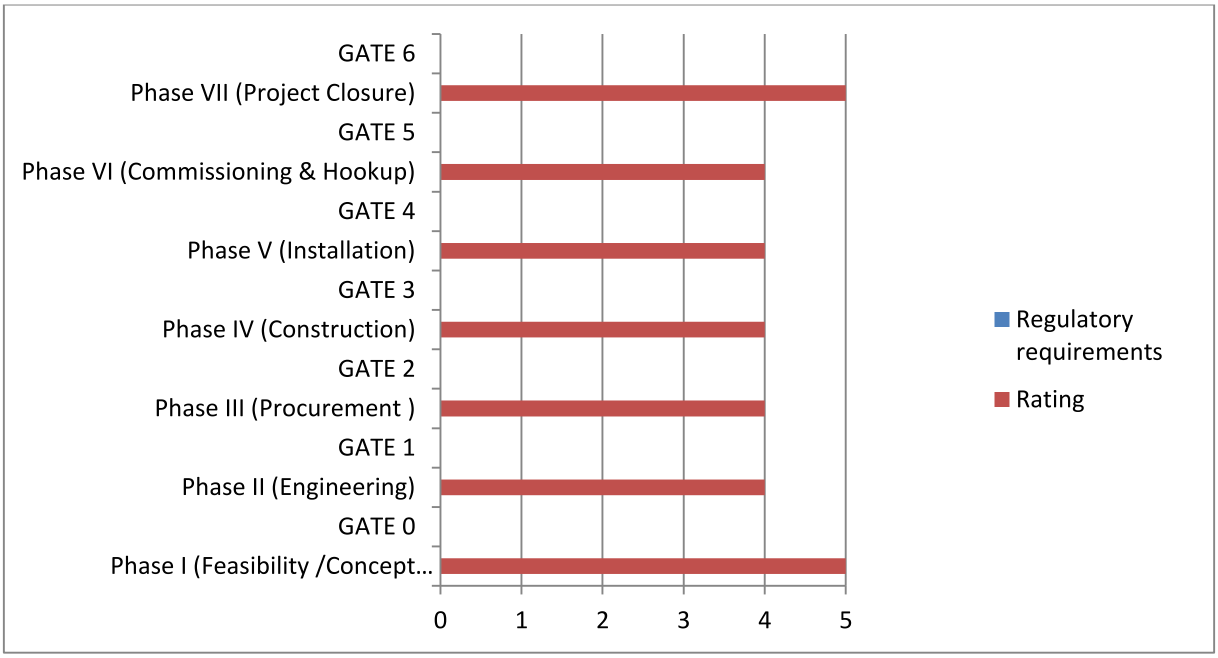


Figure 46: Visualization of Regulatory Requirements

2. Visualization of Costs

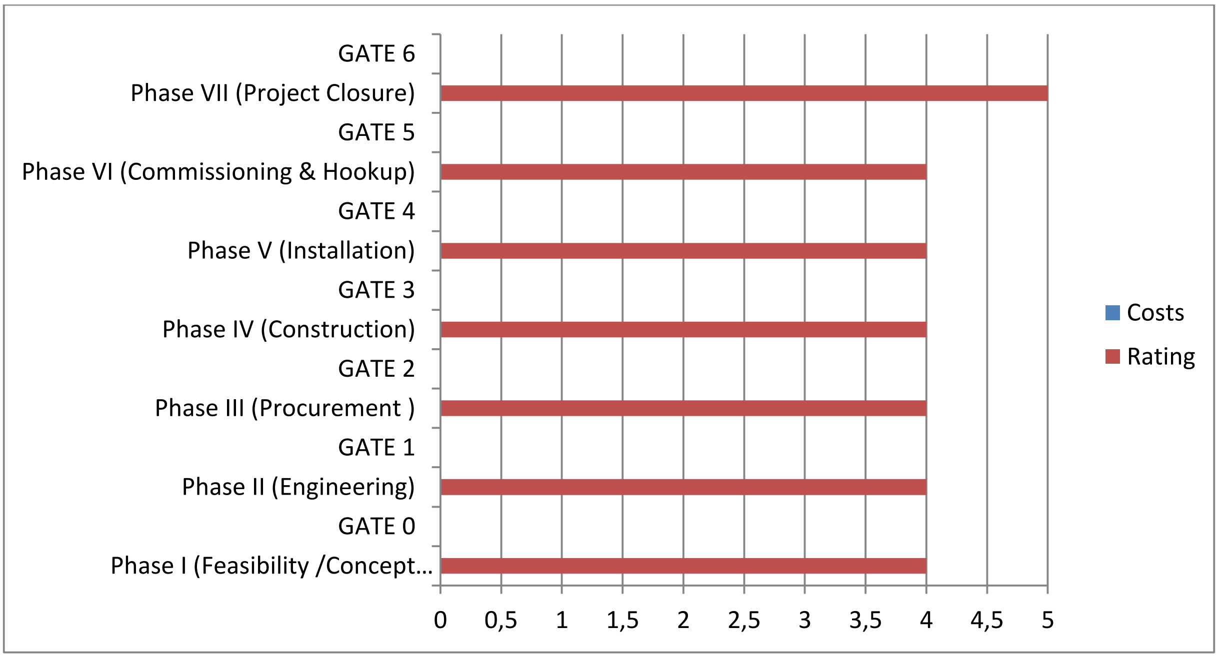


Figure 47: Visualization of Costs

3. Visualization of Quality

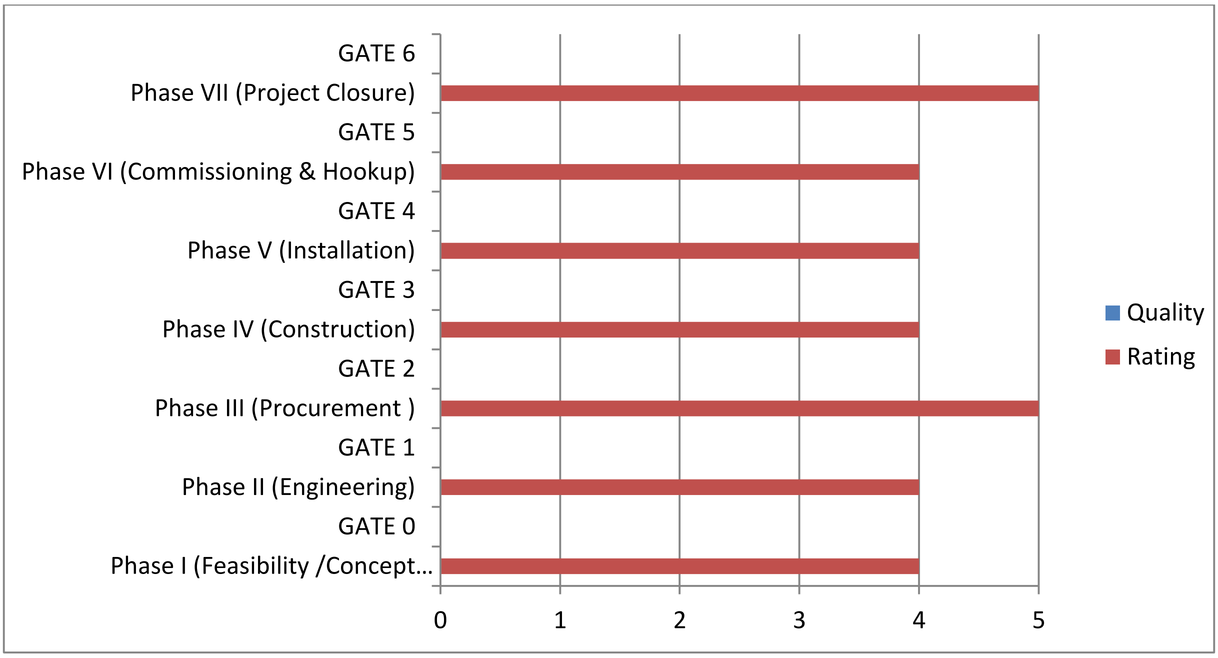


Figure 48: Visualisation of Quality

4. Visualization of Readiness of Technology & Competence

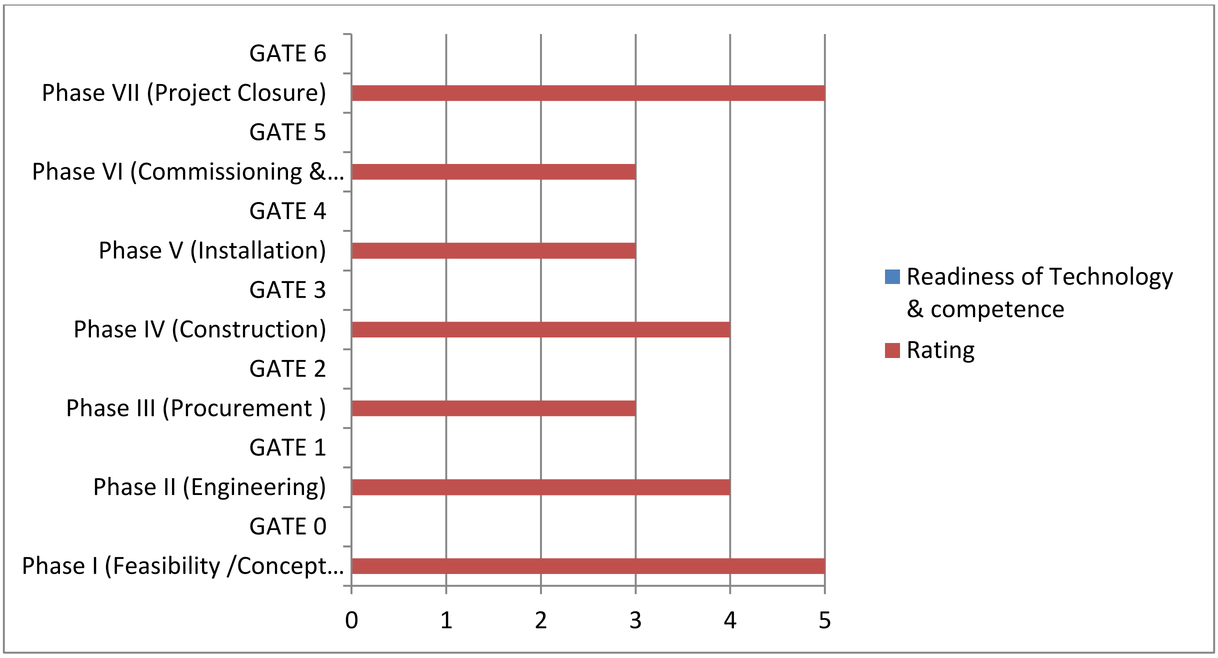


Figure 49: Visualization of Readiness of Technology & Competence

5. Visualization of Readiness of Project Risks

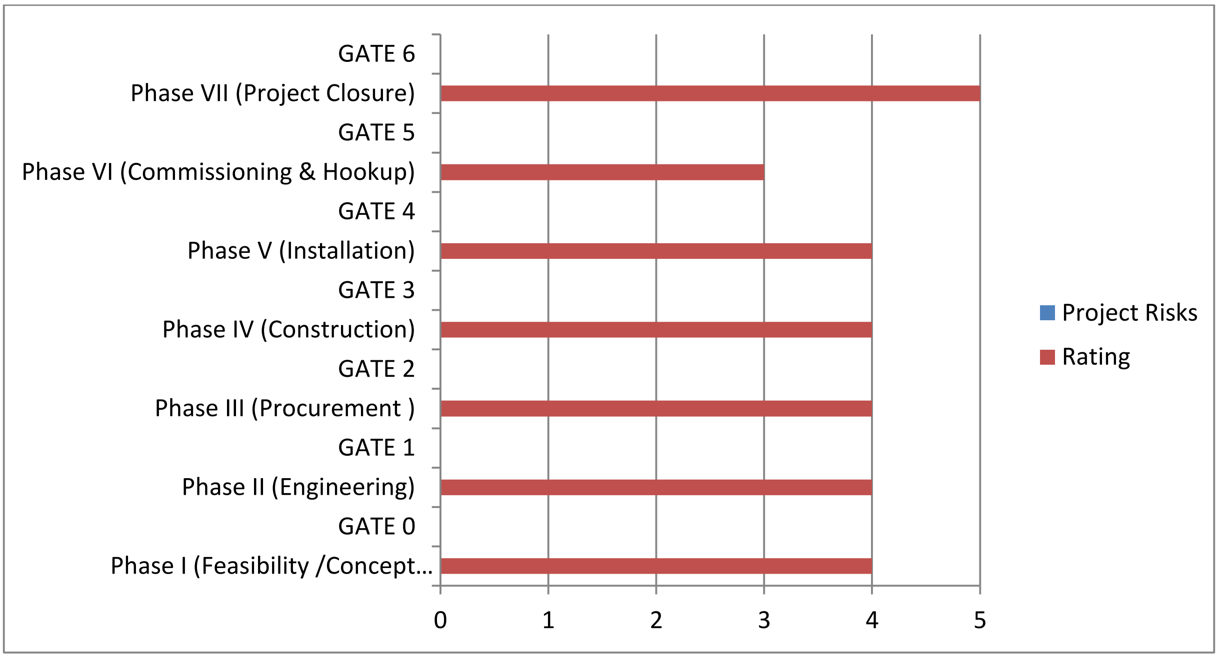


Figure 50: Visualization of Project Risks

6. Visualization of Schedule vs deadline (Progress)

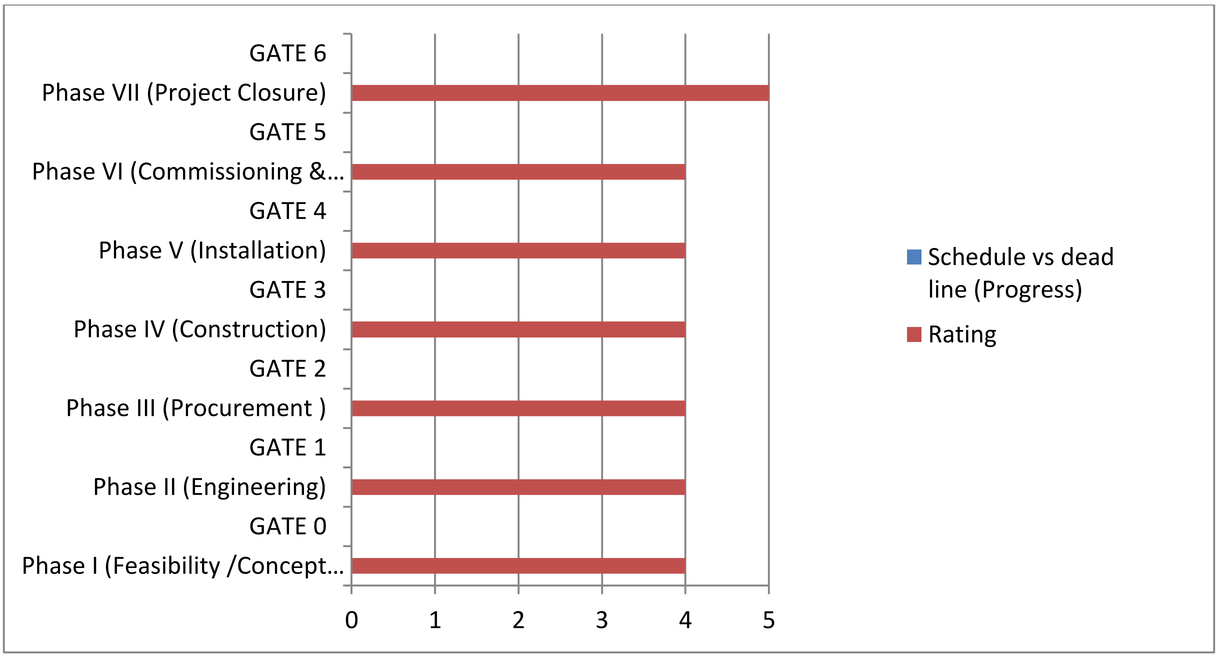


Figure 51: Visualization of Schedule vs deadline (Progress)

7. Visualization of Deviations & Change Management

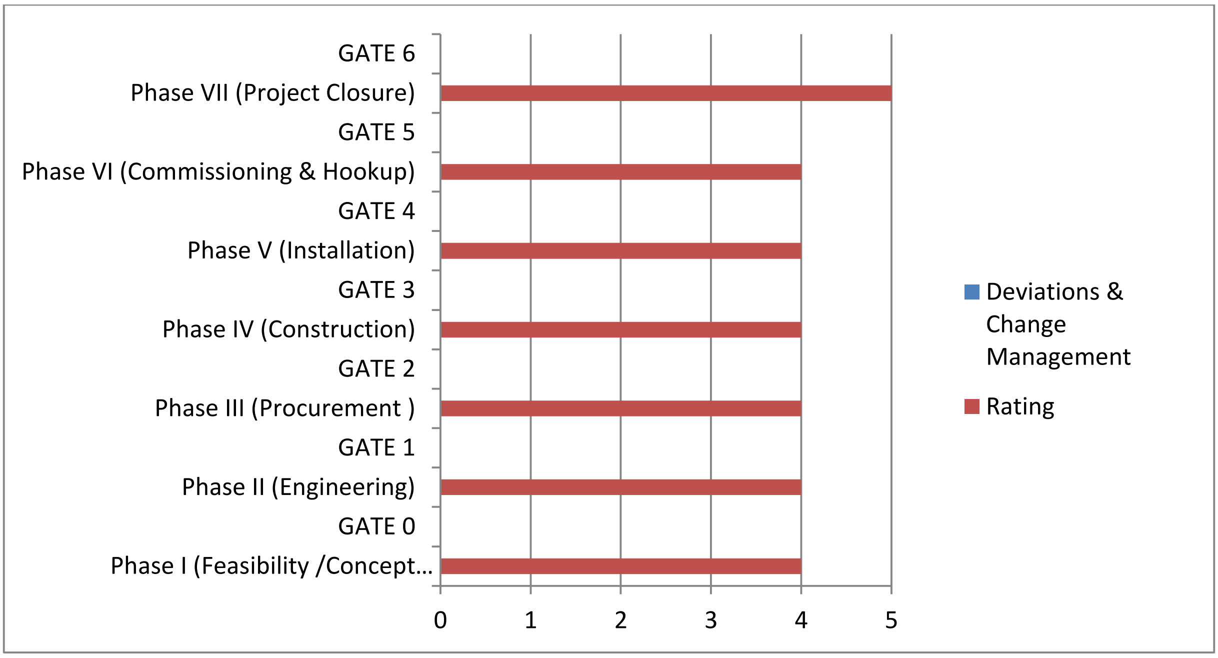


Figure 52: Visualization of Deviations & Change Management

8. Visualization of Safety & Working environment regulations

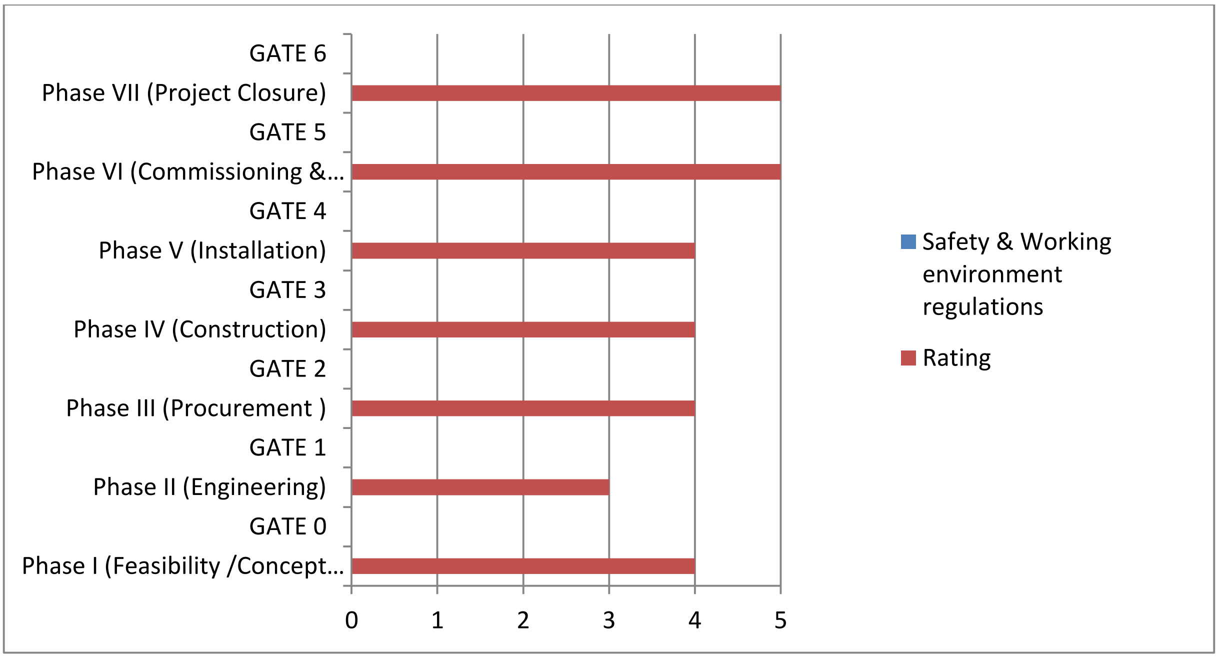


Figure 53: Visualization of Safety & Working environment regulations

9. Visualization of crucial decisions, uncertainty

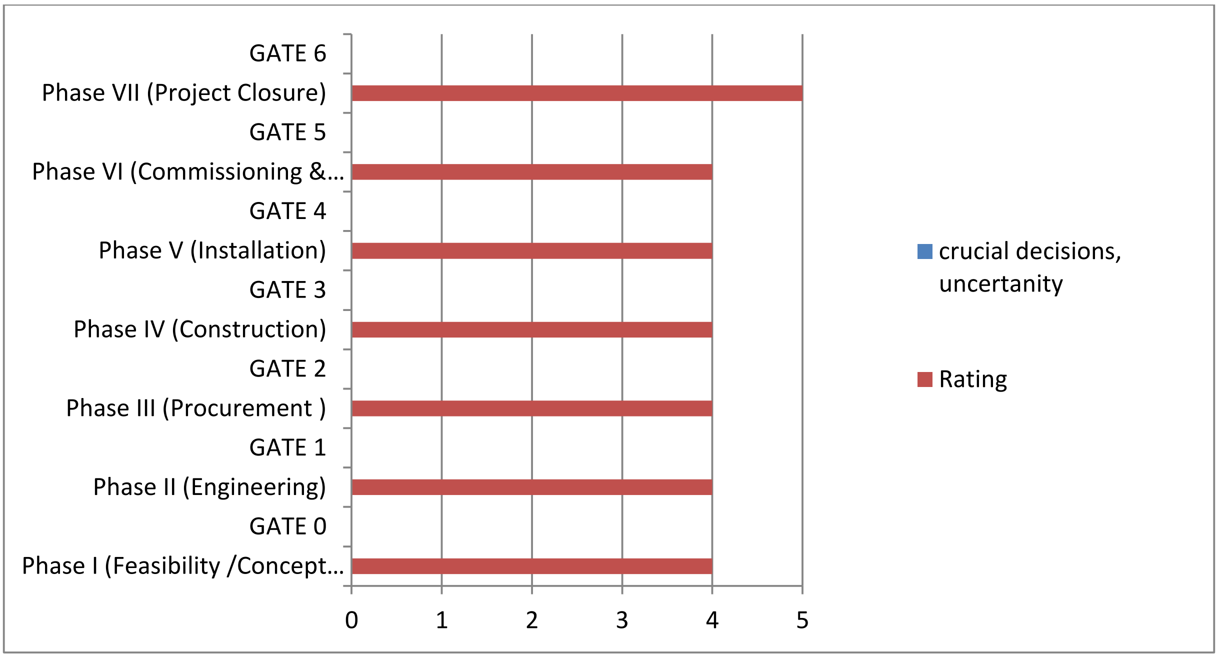


Figure 54: Visualization of crucial decisions, uncertainty

10. Visualization of Communication & interface management

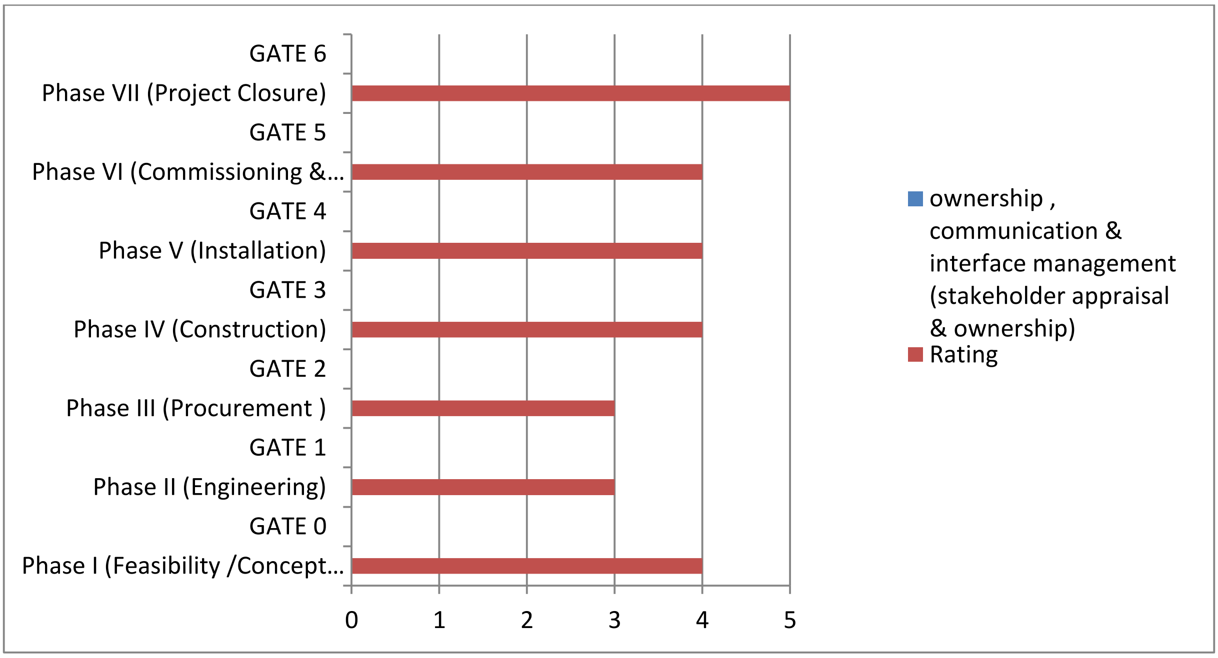


Figure 55: Visualization of Communication & interface management

Chapter 5 Analysis

The template developed in Chapter 4 will now be applied on the Skarv Project to show that the template developed above effectively captures the failure(s) very early, thereby reducing the delay of the respective project.

5.1 Application of the Project Evaluation Template to Skarv

As discussed in Chapter 3.2.1 (Root causes for project delay), the Skarv Turret is one of the key reasons for Skarv Project Delay. We shall now rate the Skarv project (considering only the Skarv Turret work package) with respect to the developed template.

Figure 56: Manifold and Gantry of the Skarv Turret (SBM, 2013)

The installation phase of the Skarv is rated per the rankings in the template (A: Excellent

B: Very Good   C: Good   D: Moderate   E: Weak)

We have ranked the completed installation phase as “**D**”. This lower rank is given since Skarv Installation phase couldn’t meet the laid GATE 4 Check Point criteria (i.e., Installation complete on planned time with no significant HSE or other concerns).

Fabrication and installation of the hull and topsides were done by South Korea’s Samsung Heavy Industries. Dutch contractor , SBM Offshore designed the turret and mooring system and it was built at the Keppel Shipyard in Singapore The 77.4m high , 7500 tons turret with riser/umbilical slots (14 phase one and 8 spare) shall take mooring loads of 5500 tons (Maslin, 2013)

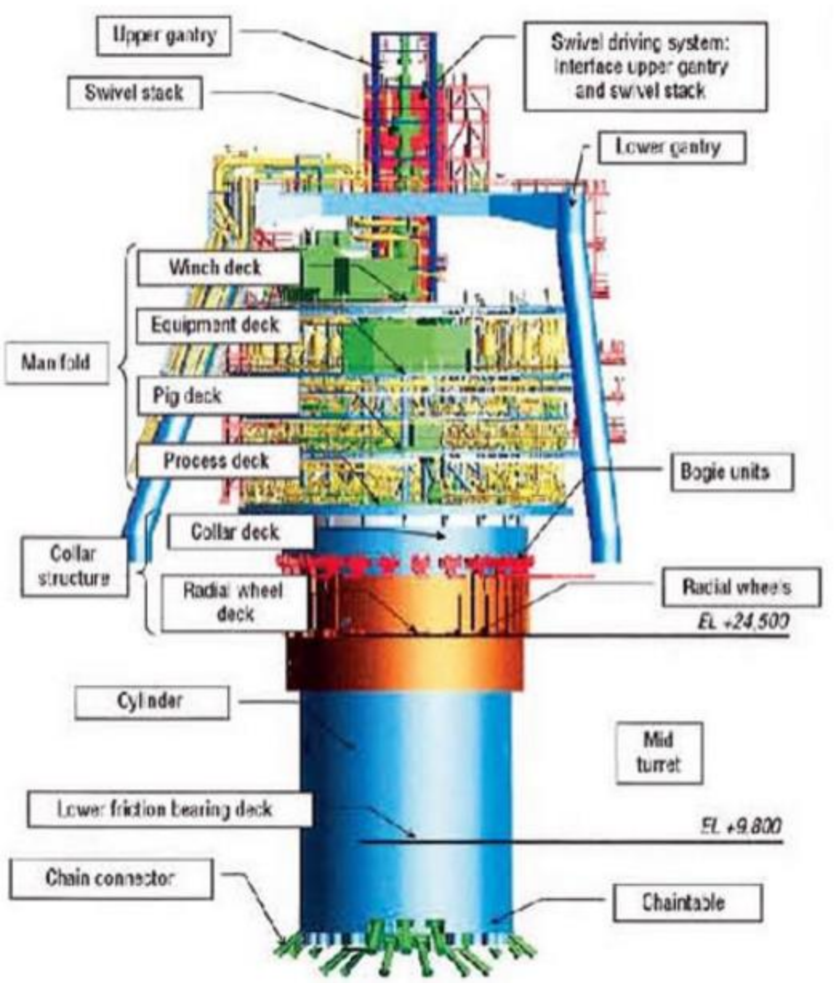


Figure 57: Skarv Turret details (Maslin, 2013)

The project remained on track with the delivery of the turret from Keppel to South Korea, turret being installed on the FPSO at Samsung Heavy Industries and the completed FPSO arrived to Norway as per the planned schedule time.

When the FPSO arrived in Aker Stord, some leaks in the piping system of the unit was identified. According to Geir Edvardsen , transport and installation manager of BP, fabrication defects on the FPSO turret led to the leaks in the piping systems (Root, 2012). Some corrective repair was carried to fix the flange leaks in the turret. Apart from the turret repair work, the repairs on the topsides of the FPSO and repairs on the riser pull-in winch had a knock-on effect on the project delivery. This led to a longer stay of the FPSO (5 weeks) in Stord and the FPSO was moored in the field late-August 2011. Due to this the installation offshore is pushed than the original planned schedule. This had significantly contributed to the cost & schedule overrun on the Skarv Project (Maslin, 2013).

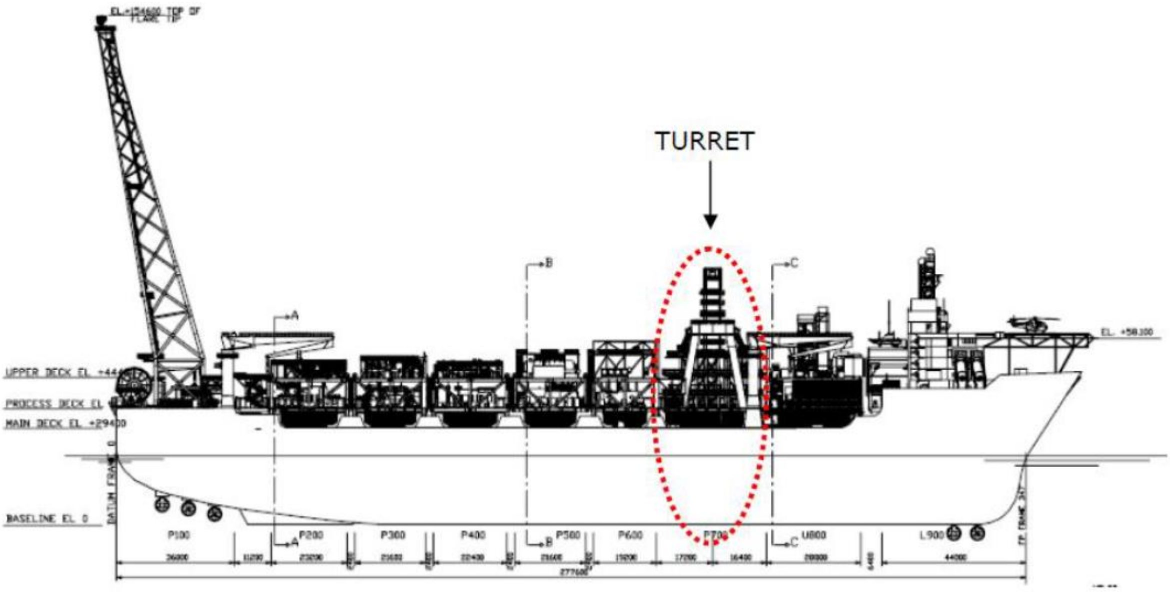


Figure 58: Skarv FPSO with the turret (Rasmussen, 2012)

How shall the Project Evaluation Template would capture the issues?

According to Geir Edvardsen , transport and installation manager of BP, fabrication defects on the FPSO turret led to the leaks in the piping systems.

Some of the potential reasons for the flange leakage could be due to the following:

-Incorrect design

-Incorrect torqueing of bolts

-Some leakage proof seal(s) might have been damaged during pressure testing at the supplier facility

- Some corrosion issues might have occurred before installation of the turret onto the FPSO at Samsung Heavy industries in South Korea (Critical seal area(s) might have been corroded due to improper protection)

The current proposed template shall effectively could have captured the turret issues as explained below:

1. These issues effectively could have been captured through the devised " Project Evaluation Template" Engineering Phase GATE 1 Check Point as shown below (Refer to Appendix B)

- Designs prepared shall be checked and approved by competent professional or principal engineer (No design changes later)

If the design was not proper the above check point shall capture the issue. The design shall be checked and should be approved by a principal engineer or above which ensures that inefficient designs shall not escape from this stage.

2. These issues effectively could have been captured through the devised " Project Evaluation Template" Procurement Phase GATE 2 Hold & Check Points as shown below (Refer to Appendix B)

-Products/materials not delivered according to standards
-Approved materials/WorkPackages
- Approved Project Quality audits (quality of delivery prior to taking the project to the next phase)

During the procurement stage relevant material certificates, test certificates (hardness, impact tests, Charpy impact toughness test etc), weld documentation, NDT testing reports (Ultrasonic testing , liquid penetrant testing, magnetic particle testing etc) , quality audits at this stage should have well captured the procured materials defects. Material (wrong material) not meeting the specified quality, governmental regulations (NORSOK, TR, ISO, API etc) shall be checked at this stage.

3. These issues effectively could have been captured through the devised " Project Evaluation Template" Construction Phase GATE 3 Check Points as shown below (Refer to Appendix B)

-Approved Material certificates, testing procedures (FAT documents etc.) and other documentation
-Sign off all build and fabrication, correct drawings and revision issued. Correct materials and components for assembly. CE markings, NCS compliance, ATEX proof, API spec etc.
-Follow-up of the construction at contractor's sites
- Approved Project Quality audits (quality of delivery prior to taking the project to the next phase)

Defects are most likely to be picked up on site if there is regular monitoring and testing. The leaks in the turret would have been identified by qualified project personnel early at the vendors construction site (SBM offshore, Singapore site) while witnessing the FAT tests (Factory Acceptance Testing).

These could be early captured through approved material certificates, FAT testing signed both by the vendor and certifying authorities such as DNV, Lloyds Register, ABS, BV, etc.

Any seal damage issues, corrosion issues should have been well captured using the proposed GATE checkpoints mentioned above during mechanical completion phase.

Thus the defective turret should have been identified and filtered in the 3 Phases (Engineering, Procurement & Construction) through using the proposed Stage Gate Check Points/Hold points, before they have been identified just before installation phase when the FPSO had arrived in Stord facility.

It was costly affair to rectify the leakage issues in the turret during the installation phase. Had this been identified during the other phases, it could have significantly contributed to minimise the project failure.

Chapter 6 Discussion and Conclusion

The objective of this thesis is to develop a "Project Evaluation Template" applicable for the Oil & Gas Industry that shall effectively capture the project issues very early thereby reducing potential project delays.

KISOLL EU Project template was taken as a reference and it is refined to suit the EPCIC model for Oil & Gas industry. The critical evaluation parameters that were identified in this thesis helps in getting a better insight across the deliverables in each EPCIC project phases. This thesis reveals how the Stage Gates Management Process (with Hold points & Check points) helps in capturing project issues very early, thereby thereby reducing potential project delays.

The proposed PRINCE2 (Projects IN Controlled Environments) Project Execution Model in this thesis helps in driving the project in the correct direction through controlling & escalating issues to higher level for effective decision making.

In this thesis, the analysis done on the Skarv Project (ie., Skarv turret workpackage) proves the functional capability of the developed "Project Evaluation Template" . The "Project Evaluation Template" thus fulfils the objectives of the thesis.

This thesis shows that the "Project Evaluation Template" had some potential positive contribution in terms of decision making, capturing issues & uncertanities .

The developed template should be tested on more live cases to know potentail practical usage.

In all , this thesis concludes that "Project Evaluation Template" has a good potential for effective decision making.

Chapter 7 Suggestions for Future Study

This thesis can be extended to portfolio management. Portfolio management deals with how to do the "right" projects and programs in the context of the organization's strategic objectives, and how to do them "correctly" in terms of achieving delivery and benefits at a collective level. It is recommended to introduce the concept of Governance and Assurance, throughout corporate group i.e. at portfolio, Programme and project level.

Training project personnel in Governance and Assurance helps in better understanding of the project. This thesis can be extended to cover Risk Management at project & Portfolio level.

Organizations now need to look at developing a programme framework in the first instance. Current project management approach is much output focused and there should be a well-defined clear line of sight between a project output and benefits. This is achieved by aligning projects tightly with corporate strategic priorities. Hence, looking at portfolio management is a key imperative.

Portfolio, Programme and Project Management Maturity Model (P3M3) helps an organization to assess its present maturity regarding project, programme and portfolio management. This is an excellent starting point, if an organization wishes to embed project, programme, portfolio or all three levels of management. This thesis can be extended to cover focus on the P3M3 model.

Appendix A: Critical Parameters needs across each phases

Critical parameter with respect to a phase (critical parameter vs phase)	Critical Parameter needs
1A (Phase I vs Regulatory requirements)	1. Reference to PSA: Management Regulations Barrier management 2. Facilities shall be based on the most robust and simple solutions as possible (Facility regulation) 3. Framework Regulations: Industry standard compliance, local authority requirements (NORSOK Standard Z-013, & S-003;ISO 19906 etc) 4. Requirements set by NMA, DSB (Civil Protection), NOFO (the Norwegian Clean Seas Association for Operating Companies).
1B (Phase I vs Costs)	1. Development costs approved by PDO (Investment costs should be stated in accordance with NORSOK standard Z-014. Operating costs should be included, and separate profiles should be stated for CO2 tax and NOx tax.) 2. Establish budget tolerance (tolerances +/- 30%) 3. Ensures estimates are realistic (Costs at this stage will be rough estimates. Costs shall be refined at next stage) 4. Capex Evaluations. 5. Opex Evaluations & Life cycle evaluations. 6. Profitability calculations before and after tax (taking discount rate into consideration) 7. Price sensitivities 8. NPV or project's profitability
1C (Phase I vs Quality)	1. Quality Management plan (Quality must meet user or client requirements) 2. Quality register 3. Quality specs set (DNV standards, API standards, PSA standards, ISO standards, Statoil TR etc.)

1D (Phase I vs Readiness of Technology & competence)	1. Qualification and use of new technology & new methods(Evaluation of potential need to develop new technology and/or use untraditional solutions) 2. Management of technology uncertainty 3. FEED studies: Re-Concept studies/ option evaluations, Technology selection 4. Technical Risk identification, further options, and strategic advisory to improve designs and installations, exploitation economically 5. Work Processes 6. Resources 7. Automatization level of technical processes 8. Operability (Easy to start or shut-down, Operative flexibility etc.) 9. address concepts, selection, development issues (especially considering regulatory compliance)
1E (Phase I vs Project Risks))	1. Project Level Risks 2. Contracts Risks 3. Identify major Cost Factors, Cost escalation Risks 4. Schedule Risks 5. Integration Risks 6. Execution Risks 7. Government Risks 8. Macro Risk factors like. Political Risks, Tax & Regulations 9. Global Economic Risks (Oil Prices) 10. Global Inflations 11. Contingency budget or risk budget (proposed to have +/-)
1F (Phase I vs Schedule vs dead line)	1. Set Preliminary Plan 2. Schedule for the project execution 3. Risk of problems during well construction 4. Schedule for drilling (drilling season etc.). Efficient detailed planning of the drilling and completion operations 5. Detail level for overall plan (work packages level also) .E.g., Implement Work Breakdown Structure in this phase (packages and level of detail required etc.).

1G (Phase I vs Deviations & Change Management)	1. Establish a Change Order Management Philosophy 2. Identify variances early in this phase, if any 3. Update Business case and check if business case valid
1H (Phase I vs Safety & Working environment regulations)	1. Reference to Norwegian Environment Agency, Norwegian Directorate of Health: 2. Major accident risk is as low as possible 3. safety functions are maintained 4. minimize chemical hazards 5. Risk reduction principles implemented 6. Safety Studies, HAZOP, HAZAN, Layout studies completed 7. Acceptance criteria for environmental risk and major accident risk 8. Risk analyses and emergency preparedness assessments. Working environment analysis 9. Possibility to drill relief wells in case of blow-out 10. Sensitivity of facility to critical conditions (to environmental loads) 11. Ability to leave the site in case of accidence (disconnection capability). Plan for disposal and decommissioning legislation
1I (Phase I vs crucial decisions, uncertainty)	1. Technology qualification. Uncertainties including Technical Risks 2. Basis for making decisions and decision criteria 3. Reliability, Availability Risks 4. Construction Risks 5. Risks of problems during well construction (Well control incidents, Failures of downhole and surface equipment ,stuck drill string, etc) 6. requirements for risk reduction and best available technique (BAT), energy efficiency requirements 7. Issues shall be resolved (through escalation and managing by exception)

1J (Phase I vs communication & interface management)	1. Communication among Stakeholders (licensees) 2. Consentment of the decision 3. Interface Management (User, Supplier, Project Executive reporting to Corporate or Programme) 4. Define Scope of Work 5. Suggest and establish a project organization with involvement of project & operation personnel in all phases of project. 6. Operability criteria 7. Decisions beyond PM authorization or control or tolerances to rectify must be communicated. Deviations escalation and managing by exception 8. Organization chart, communication plan are setup
2A (Phase II vs Regulatory requirements)	1. Third Part Design Reviews and Process Design and Operations Assurance 2. Establish relevant NORSOK, TR, DNV, ISO , IEC requirements (Design of Onshore facilities, equipment's according to prevailing standards) 3. Establish necessary technical, operational and organizational measures
2B (Phase II vs Costs)	1. Are costs estimates in accordance to PDO estimates 2. Is design cost effective and in accordance to the FEED document 3. is the cost estimates tolerances set-up
2C (Phase II vs Quality)	1. NORSOK, TR , ISO etc .Ensure quality requirements are incorporated in the design 2. Qualification of suppliers 3. Material selection (load requirements, joining processes, possible future removal etc) follow PSA requirements
2D (Phase II vs Readiness of Technology & competence)	1. Standardization and new technology application are managed 2. Technical Risk identification
2E (Phase II vs Project Risks)	1. Project Level Risks. Identify major Cost Factors, Cost escalation Risks 2. Schedule Risks 3. Execution Risks
2F (Phase II vs Schedule vs dead line)	1. Identify long lead items and place an order after Engineering is completed (In order to ensure that the fabrication is done in the planned time, long lead

	items must be identified and procured to meet the schedule.) 2. Any changes in detail engineering plan needs to be approved with realistic dates
2G (Phase II vs Deviations & Change Management)	1. Handle Variations and clear this very early 2. Escalate issues with top level management and change the baseline accordingly
2H (Phase II vs Safety & Working environment regulations)	1. Environmental and safety requirements and operability/ maintainability considerations to be firmly incorporated. Use of recommended standards in the health, safety and working environment area (e.g. standards that have been prepared under the auspices of CEN, CENELEC, ISO and IEC, will be normative). 2. Incorporating working environment factors in the design of onshore facilities
2I (Phase II vs crucial decisions, uncertainty)	Technical Risk identification, further options, and strategic advisory to improve designs and installations, exploitation economically.
2J (Phase II vs communication & interface management)	1. Communication among Stakeholders (licensees) 2. Consentment of the decision 3. Interface Management (User, Supplier, Project Executive reporting to Corporate or Programme) 4. Define Scope of Work 5. Involvement of project & operation personnel in all phases of project. 6. Operability criteria 7. Decisions beyond PM authorization or control or tolerances to rectify must be communicated. Deviations escalation and managing by exception 8. Organization chart, communication plan are setup
3A (Phase III vs Regulatory requirements)	Industry standard compliance, local authority requirements (NORSOK, ISO, DNV etc). PSA requirements have to be met
3B (Phase III vs Costs)	Procurement of materials within the Budget of projects. Cost variances , if any from suppliers and get acceptance

3C (Phase III vs Quality)	1. All products are delivered according to set quality specs NORSOK, TR, ISO etc 2. Check quality management plan
3D (Phase III vs Readiness of Technology & competence)	Technical Risk identification. Log Risk register & update risk management plans
3E (Phase III vs Project Risks)	1. Contracts Risks 2. Identify major Cost Factors, Cost escalation Risks 3. Schedule Risks
3F (Phase III vs Schedule vs dead line)	1. production progress control after order 2. Transportations to sites according to a project schedule.
3G (Phase III vs Deviations & Change Management)	1. Handle Variations and clear this very early 2. Escalate issues with top level management and change the baseline accordingly
3H (Phase III vs Safety & Working environment regulations)	1. See that requirements set in the FEED stage is maintained in this stage
3I (Phase III vs crucial decisions, uncertainty)	1. regulatory risks 2. Supplier risks, buyer risks 3. competition risks 4. manpower risks 5. Reliable contractors
3J (Phase III vs communication & interface management)	1. Communication among Stakeholders (licensees) 2. Consentment of the decision 3. Interface Management. Involvement of personnel (project, offshore etc) in all project phases and decision making process 4. Modified Scope of Work , if any 5. Approved deviations if any from the supplier needs approval
4A (Phase IV vs Regulatory requirements)	Industry standard compliance, local authority requirements Eg NORSOK fabrication standards (NORSOK M-101 Structural steel fabrication standard, NORSOK N-004, etc), ISO standards (ISO 19902 specific requirements to welding, fabrication and NDT) piping standards (NORSOK L-CR-003, NORSOK L-004) Pressure equipment directives, welding standards (ASME B31.3, NORSOK M-601 welding and weld inspection of piping systems), electrical standards, PSA installation rules and regulations.

	Relevant guidelines set NMA, DNV, PSA
4B (Phase IV vs Costs)	1. Construction costs , tolerance 2. Cost deviations if any shall be approved 3. Costs should be refined and more accurate based on engineering phase which preceded it, but also bring in contingency here to accommodate changes and change budget. 4. Allow for LLI order and budget allocation or commitment early in project phase, but also allow for market fluctuations in material, production slots, fast track build programmers as a risk
4C (Phase IV vs Quality)	1. Follow quality requirements set above by personnel with extensive knowledge on standards (qualified quality conscious personnel) at vendors/sub vendors facility 2. Quality, pre-qualified and internal and external audits. More quality requirements for NCS via DSB, NMA, PTIL/PSA etc. 3. Ensure suppliers are ISO 9001 and 14001 as a minimum. Material certificates and testing procedures and documentation essential. 4. Sign off all build and fabrication, correct drawings and revision issued. Correct materials and components for assembly. CE markings, NCS compliance, ATEX proof, API spec
4D (Phase IV vs Readiness of Technology & competence)	1. Operations Risk workshops, Operations Assurance, and Commissioning control 2. Trials, tests and certification, interface , training established, documentation and certificates 3. Warranty and support. Revision and version control. Upgrade, tailoring and specialized product verification and compliance. Skills available to build. 4. Application Harsh Environment and Artic conditions require special consideration.

4E (Phase IV vs Project Risks)	1. Project Level Risks Eg., Change and Verification management. Ready for next phase, delivery and call off. 2. Contracts Risks 3. Identify major Cost Factors, Cost escalation Risks (Control of Cost) 4. Schedule Risks (Planned vs Actual reporting.) 5. Integration Risks (Stakeholder involvement. Escalation and resolve meant of issues and exceptions.) 6. Execution Risks (Allocation of resources, utilization and efficiencies. Sub supplier deliveries, packages and assemble interface issues) 7. Delivery risks (Product delivery in accordance with rules , regulations and governance/assurance)
4F (Phase IV vs Schedule vs dead line)	1. Monitor progress during construction. See this is accordance to plan, for any deviations get approval 2. monitor and control contractor's work 3. Minimal time of assembly works and material supply with maximal flexibility (possibility of equipment replacement if it is necessary) 4. construction Planning/ Vendor management/ Yard works and Operations management during project 5. Project controls and reporting mechanisms established
4G (Phase IV vs Deviations & Change Management)	1. Have good commercial team to handle change orders and get it approved sooner 2. Change management procedure and process in place. Variations or changes can change throughout process so not all can be cleared early. 3. Cost time quality, benefits and delivery changes signed off and verified by client. Some changes internal due to inaccurate procurement or order process. Punch lists and repairs, changes in FAT. Interface issues.
4H (Phase IV vs Safety & Working environment regulations)	1. Follow regulations set in above phases. Meet rules and regulations laid

	2. HSE activity coordination & site safety management during the construction phase (safety of the workers) 3. FAT punch lists etc.
4I (Phase IV vs crucial decisions, uncertainty)	1. Complete Process design with firm decisions on Installations, Design basis, and Operational requirements. 2. Ensure Risks are identified and are mitigated or close out. 3. Perform components and material checks / verification against I.A.W rules & regulations, API Specifications and Purchase Order. Ensure Sub Suppliers and suppliers of equipment meet these.
4J (Phase IV vs communication & interface management)	1. Communication among Stakeholders(licensees) 2. Consentment of the decision 3. Interface Management (Interface, Stakeholders: project escalation) 4. Risks and Consequences documented. All instructions in writing. Reporting format and frequency needs to be setup
5A (Phase V vs Regulatory requirements)	1. PSA Regulations for installation 2. industry standard compliance, local authority requirements (NORSOK ,ISO etc)
5B (Phase V vs Costs)	1. Monitor costs 2. check against baseline costs , if any deviations get the required approvals 3. Have good control of actual hours (with respect to costs) for any changes essential, delay wait on weather, no access etc
5C (Phase V vs Quality)	1. Refer to Quality Management plan 2. Establish Maintenance plans 3. Programs including Criticality Analyses and Spare Parts Evaluation, Operational Documentation (technical procedures delivered include: Start-up Procedures, Normal Operation, Planned shutdown, etc) 4. Mechanical completion should be signed off at installation
5D (Phase V vs Readiness of Technology & competence)	1. Qualification and use of new technology & new methods, if needed 2. Installation procedures to be implemented efficiently to attain

	reliability and quality that is performed in a timely and orderly manner that is highly affected by the personnel's expertise on the assigned task. 3. Ensure nothing will be installed if not certified or trial results (the trials which were established in construction and FAT phase) are known. 4. Functionality and Operability must be known, sufficient training also undertaken. 5. Have additional site supervisors and superintendents to represent new technology needs. Establish 24 hour support line. 6. Provide Training and updates of systems (integration into Alarm system. Emergency shut down and a safe standby etc) 7. Manual overrides and precautions during commissioning and operation phase also to be established before installing/MC (normally when no power on).
5E (Phase V vs Project Risks)	1. Project Level Risks like Contracts Risks, Schedule Risks & Execution Risks shall be identified, Controlled, Accepted or Rejected. Maintain issues log. Issues shall be escalated or managed by exception. 2. Ensure Users and Suppliers and Client all support this phase.
5F (Phase V vs Schedule vs dead line)	1. Acceptable duration of transportation and installation in unfavorable weather conditions with capacity for flexible performing of operations. Contract for the work must be placed to ensure that the time is met. 2. Look at issues such as prolonged duration of transportation and installation, lack of flexibility etc. 3. Ensure the project plans are followed, if any changes get it approved (Ensure Project controls and package and management reporting set up correctly)
5G (Phase V vs Deviations & Change Management)	1. Have good commercial team to handle change orders and get it approved sooner

	2. Establish good change management systems to take care of changes like delay wait on weather, no access etc 3. Establish good plan to deco flick and time lifts, plan entry and exit roots for demolition and removal or upgrade. Also look at modular lifts, tools and interface between different companies and departments. 4. Develop Risk and Decision Making procedure and communication plan to back it up 5. Ensure there is good Interface management and QHSE involvement to identify any details. Level 5 detail required here. Changes must be updated in plan to see impact. 6. All deviations to be signed off, (ensure written documentation than having a simple verbal communication)
5H (Phase V vs Safety & Working environment regulations)	1. safety functions are maintained 2. minimize chemical hazards 3. Risk reduction principles implemented 4. Prepare offshore /onshore emergency preparedness 5. Safety of equipment during transportation, assembly & installation
5I (Phase V vs crucial decisions, uncertainty)	1. Complexity of technical equipment layout (single staged or multi staged) is discussed 2. Requirements to perform marine operations and possibility to perform them in short period 3. Complexity of facility installation needs to be looked at, if required. 4. Develop Risk and Decision Making procedure and have communication plan to back it up (This is essential for change and approval issues.)
5J (Phase V vs communication & interface management)	1. Communication among Stakeholders(licensees) 2. Consentment of the decision 3. Interface Management 4. Efficient cross functional interaction 5. Have procedures and processes in place and ensure followed correctly 6. Also minutes, weekly reporting and escalation or managing by exception need to be documented and discussed.
6A (Phase VI vs Regulatory requirements)	1. Refer to PSA regulations

	2. industry standard compliance, local authority requirements (NORSOK , ISO etc) 3. Requirements set by NMA, DSB (Civil Protection), NOFO (the Norwegian Clean Seas Association for Operating Companies).
6B (Phase VI vs Costs)	1. cost deviations if any needs to be approved 2. Establish specific budget allocation for this phase.
6C (Phase VI vs Quality)	1. Establish Operating and Maintenance Manuals 2. Ensure that Commissioning and Startup Procedures were finalized. (Packages should specify tests and trials for equipment prior to handover. Have acceptance by client/operator. Also check if there are specific requirements from client and NCS authorities.) 3. Follow Quality Management plan
6D (Phase VI vs Readiness of Technology & competence)	1. Competence of personnel 2. Ensure commissioning and interface issues are resolved. Training and operation demonstrations may be a good idea. 3. Perform Simulations ensuring interface with platform or operations or operator systems. Also link to onshore monitoring and information systems to be considered.
6E (Phase VI vs Project Risks)	1. Look into issues such as offshore access, delay due to weather. Programme and operational issues are to be considered (and these shall remain flexible). 2. Consider having specialist commissioning equipment and data analysis and recording tools (also ensure this equipment is called off).
6F (Phase VI vs Schedule vs dead line)	1. Mechanical completion monitoring, verification and control 2. Look into Pre-Com/ Commissioning monitoring, sequencing and control. 3. (Schedule is met in case the top side is functional and placement of additional ballast is planned properly) 4. Have strict project controls and monitoring. Have Daily, weekly and

	monthly reporting. Establish good contact between commissioning lead and onshore / operators.
6G (Phase VI vs Deviations & Change Management)	1. Have good commercial team to handle change orders and get it approved sooner 2. Commissioning team shall have good interface with Installation team and Onshore team to resolve differences. 3. All changes need to be approved. Must be agreed upfront who is liable for rework or repair (e.g., could be fault based on specifications). 4. Must understand warranty and guarantee process and have Original Equipment Manufacture support as required.
6H (Phase VI vs Safety & Working environment regulations)	1. safety functions are maintained 2. minimize chemical hazards 3. Risk reduction principles implemented 4. Prepare offshore /onshore emergency preparedness 5. Safety of equipment during transportation, assembly & installation 6. Have precaution when using commissioning; prevent spill or high energy impact/damage. Particularly sensitive for rig Fire & Gas and Alarm system. 7. Have additional procedures for recovery if things go wrong. Only competent and trained people. Use Task based risk assessment and toolbox talk.
6I (Phase VI vs crucial decisions, uncertainty)	1. Complexity of technical equipment layout (single staged or multi staged) need to be discussed 2. Requirements to perform marine operations and possibility to perform them in short period 3. Complexity of facility installation need to be considered 4. Must document and analyze results of commissioning phase, liaise with OEM. Issues to be escalated and managed.
6J (Phase VI vs communication & interface management)	1. Communication among Stakeholders (licensees) 2. Consentment of the decision

	3. Interface Management (Involve Operators, User and Suppliers in all decisions.) 4. Efficient cross- functional interaction (informs when underway and complete, results documented and distributed. If changes consider consequences, impact and seek permission to proceed. If it does not go according to plan, propose recovery, seek approval or direction)
7A (Phase VII vs Regulatory requirements)	industry standard compliance, local authority requirements are to be met
7B (Phase VII vs Costs)	Ensure costs are as per the business case. And also allocate budget for this phase.
7C (Phase VII vs Quality)	1. Ensure products are delivered according to quality requirements and in accordance to quality management plan 2. Report and compliance to be confirmed. Agree functionality and see operability is achieved. Ensure all benefits realized.
7D (Phase VII vs Readiness of Technology & competence)	1. Have performance monitoring and follow up. 2. Maintenance and Lifecycle issues, upgrades and revision or software updates to be considered as applicable.
7E (Phase VII vs Project Risks)	The following needs to be looked in this stage: Any outstanding punch or repairs outstanding. Any future upgrades and mods planned.
7F (Phase VII vs Schedule vs dead line)	1. Ensure project is delivered according to the plan (on time, to quality and cost.)
7G (Phase VII vs Deviations & Change Management)	1. Cost consolidated against planned budget and changes or variations incorporated. 2. Ensure all contingency used accounted for. Funds should be allocated if follow up work required and guarantee, warranty budget set.
6H (Phase VII vs Safety & Working environment regulations)	1. Is it safe and ergonomic and compliant. 2. Any temporary measures in place which must be remedied within reasonable time frame ca. 6 months. 3. Are personnel properly trained and familiarized. Feedback and follow up. Audits and WEM/HSE checks.

7I (Phase VII vs crucial decisions, uncertainty)	1. Ensure disputes are resolved. Have Client signed off, if not control or escalate or manage by exception as necessary.
7J (Phase VII vs communication & interface management)	1. Customer acceptance/Lessons learned Report 2. Check Business case (assess the projects performance against its requirements and the likelihood that the outcomes will provide the expected benefits) 3. Close out meeting. Close out report, Close Risk and Issue Register. 4. Maintain personnel to follow up through life support.

Appendix B: Stage Gates with Hold Points & Check Points

GATE	HOLD POINTS	CHECK POINTS
GATE 0	1. Unclear Business Case 2. Partial/Incomplete FEED Report 3. Inefficient Project team 4. No clear Project Plan (Estimates submitted to PDO shall be realistic with enough tolerances set-up) and detailed Stage Plan (eg., ensure there is no exaggerated optimism, unrealistic ambitions, deficient understanding of the uncertainty) 5. Tolerance plan not setup/Acceptance criteria not established 6. Unidentified Project risks and not establishing a corrective action plan 7. Regulatory requirements not met/unclear 8. Not optimal decisions 9. Ineffective contract strategies (supplier contract strategies) **10.** Poor Portfolio management	1. Approved Business Case 2. Approved decisions/updated exception plan 3. Prequalification of vendors. 4. Updated Quality plan/procedures, Risk plan/procedures, Stage level Plan 5. Implemented Lessons learnt from previous similar cases 6. Approved project plan, quality plan. Establish effective Project management team. Governance & Performance management problems are well taken care of (ie agreement on critical plans and procedures) 7. Approved Readiness of technology & competence 8. Completed FEED 9. Qualification of new Technology, if needed 10. Effective Contract Strategy for equipment is identified 11. Authorisation of project and formal permission to proceed (albeit in some cases with caveat I.e rework and resubmit application to address issues that need to be corrected) 12. Accepted Investment appraisal. (Cost, return on investment, discounted cash flow, net present value etc) 13. Successful FEL (Front End Loading) 14. Estimates set-up with good tolerances (costs, time etc)

		15. Approved suppliers who can deliver products according to quality standards **16.** Well managed Governance and Assurance (audits, QHSE. Client or internal audits)
GATE 1	1. Incomplete Detail Engineering of all work packages (All Detail Engineering completed. Complete set of deliverables including Process Design Basis, Design Criteria, Equipment detailed designs, line list, and Instrument and control datasheet and philosophies.) 2. Technical issues not escalated/cost issues and clarification not completed Vendors are not prequalified ie., Vendors are not clear of all TR/NORSOK and other regulations 3. Standardization and new technology qualification not complete 4. Unclear SOW **5.** Ineffective supplier contact strategy (ie., effective contract strategies help to mitigate the risks of schedule/cost delays)	1. Completed Detail Engineering before ordering critical work packages. 2. Designs prepared shall be checked and approved by competent professional or principal engineer (No design changes later) 3. Qualification of vendors for technology, standards 4. Approved Deviations, if any (Change control as this will affect scope and business case) 5. Updated Plan/Reports(costs-vendor, drilling etc , time) 6. Updated procedures (Risk, Quality etc) 7. Updated Stage level plan (detail work package level plans etc) 8. Approved design checks carried out by DNV or other competent body (Checks by PSA and DSB and DNV. Sign off approved design) 9. Efficient Project Management team with realistic estimates. Governance & Performance management problems are well taken care of (ie agreement on critical plans and procedures) 10. Well managed Governance and Assurance (audits, QHSE. Client or internal audits) **11.** .Manage by exception and reporting (quality and progress)

GATE 2	1. Products/materials not delivered according to standards 2. Incomplete technical clarifications from suppliers 3. Change orders if any are not clarified and approved 4. Inefficient personnel expertise (can be 3rd party, or sub vendors etc) 5. Unclear SOW 6. Critical equipment/work packages not procured 7. Failed Vendors commitments (in terms of quality, schedule, costs etc)	1. Approved materials/Work Packages 2. Approved change orders/deviations if any 3. Approved Business case from Stakeholders 4. Approved commitments from vendors 5. Updated procedures (Risk, Quality etc) 6. Direct supervision of critical work packages should be done by the operators to avoid schedule delays 7. Approved Project Quality audits (quality of delivery prior to taking the project to the next phase) 8. Well managed Governance and Assurance (audits, QHSE. Client or internal audits)
GATE3	1. Unclear and underestimated SOW 2. Unapproved deviations during construction phase 3. Safety concerns and Environmental regulations not met 4. Unclear contractual requirements and Norwegian working environment requirements.	1. Completed work packages. Ready installation procedures , documents etc 2. Approved change orders if any 3. Approved Material certificates ,testing procedures (FAT documents etc) and other documentation 4. Sign off all build and fabrication, correct drawings and revision issued. Correct materials and components for assembly. CE markings, NCS compliance, ATEX proof, API spec etc 5. Updated Plan (taking consideration into favorable weather conditions for installation etc) 6. Follow-up of the construction at contractors sites 7. Approved Project Quality audits (quality of delivery prior to taking the project to the next phase)

		8. Updated procedures (Risk, Quality etc) **9.** Well managed Governance and Assurance (audits, QHSE. Client or internal audits)
GATE 4	1. Unclear and underestimated SOW 2. Safety concerns and Environmental regulations not met **3.** Un-updated procedures (Risk, Quality etc)	1. Installation complete on planned time with no significant HSE or other concerns 2. Updated project plan & Approved deviations, if any 3. Approved Project Quality audits (quality of delivery prior to taking the project to the next phase) 4. Updated procedures (Risk, Quality etc) 5. Well managed Governance and Assurance (audits, QHSE. Client or internal audits) 6. Ensure plans, packs and risks have been signed off and everyone agrees. 7. MC Phase must follow this quickly as this is check that installations correct before pouring up. **8.** Ensure if flushing, cleaning and removal of old equipment are considered and all done in QHSE compliant way.
GATE 5	1. Incomplete hookup & commissioning 2. Incomplete documentation **3.** Deviations not approved	1. Completed SOW 2. Approved Project Quality audits (quality of delivery prior to taking the project to the next phase) 3. Check the business case 4. Well managed Governance and Assurance (audits, QHSE. Client or internal audits)

GATE 6	Documentation not signed by authorities	1. All documentation and certificates should be delivered. All of these have to be signed off and approved by authorities. 2. All payments and acceptance criteria should be settled. 3. Ensure there are no outstanding issues or risks. All change orders should be completed. All registers and logs should be closed **4.** Ensure all benefits are realized. Project Close out report should be delivered.

Appendix C: Ranking of Critical Parameters in different phases

Critical Parameter	Project Phase	Expert 1	Expert 1	Expert 1	Final Rank (Most recurring number)
Regulatory requirements	Planning/FEED	5	5	5	5
	Engineering	4	4	4	4
	Procurement	4	4	4	4
	Construction	3	4	4	4
	Installation	4	4	3	4
	Hookup& Commissioning	4	4	4	4
	Project Closure	5	5	5	5
Costs	Planning/FEED	5	4	4	4
	Engineering	5	4	4	4
	Procurement	4	4	3	4
	Construction	4	4	4	4
	Installation	4	4	4	4
	Hookup& Commissioning	4	4	3	4
	Project Closure	4	5	5	5
Quality	Planning/FEED	4	4	4	4
	Engineering	4	4	5	4
	Procurement	5	5	5	5
	Construction	4	4	4	4
	Installation	4	4	4	4
	Hookup& Commissioning	4	5	4	4
	Project Closure	5	5	5	5

Readiness of Technology & competence	Planning/FEED	5	5	5	5
	Engineering	4	4	4	4
	Procurement	3	4	3	3
	Construction	4	4	4	4
	Installation	3	3	3	3
	Hookup& Commissioning	3	3	3	3
	Project Closure	5	5	5	5
Project Risks	Planning/FEED	5	4	4	4
	Engineering	4	5	4	4
	Procurement	4	4	4	4
	Construction	4	3	4	4
	Installation	4	4	4	4
	Hookup& Commissioning	4	3	3	3
	Project Closure	5	5	5	5
Schedule vs deadline (Progress)	Planning/FEED	4	4	4	4
	Engineering	4	4	4	4
	Procurement	4	4	4	4
	Construction	4	5	4	4
	Installation	4	4	5	4
	Hookup& Commissioning	4	4	4	4
	Project Closure	5	5	5	5
Deviations& Change Management	Planning/FEED	4	4	4	4
	Engineering	4	4	4	4
	Procurement	5	4	4	4
	Construction	4	4	4	4

	Installation	4	4	4	4
	Hookup& Commissioning	4	4	4	4
	Project Closure	5	5	5	5
Safety& Working environment regulations	Planning/FEED	4	5	4	4
	Engineering	4	3	3	3
	Procurement	4	4	4	4
	Construction	4	5	4	4
	Installation	4	4	4	4
	Hookup& Commissioning	5	4	5	5
	Project Closure	5	5	5	5
crucial decisions, uncertainty	Planning/FEED	4	5	4	4
	Engineering	4	4	4	4
	Procurement	4	4	4	4
	Construction	4	5	4	4
	Installation	5	4	4	4
	Hookup& Commissioning	4	4	4	4
	Project Closure	5	5	5	5
communication &interface management	Planning/FEED	4	4	4	4
	Engineering	3	4	3	3
	Procurement	4	3	3	3
	Construction	4	4	4	4
	Installation	4	4	5	4
	Hookup& Commissioning	4	4	4	4
	Project Closure	5	5	5	5

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