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Master Thesis Project Bas Joustra
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Risk-based Project Management at Heerema Marine Contractors

*“How to improve HMC project risk management to cope
with risks and uncertainty in complex EPRD projects”*

Master Thesis Project

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Preface

Over the past year I performed by master thesis project at Heerema Marine Contractors. This Master Thesis project is the final element of my master Systems Engineering, Policy Analysis and Management at the technical university of Delft.

The aim of this thesis project was to develop an approach for better coping with the risks and uncertainty associated with complex EPRD projects. From the analysis of the first two large EPRD projects that HMC has taken on, specific knowledge has been gathered on the effectiveness of the HMC project risk management process in practice. With the use of processes, tools and techniques identified from best practices in the field of risk management, various quick wins have been identified to improve HMC's current approach for the management of project risk. The thesis provides insight into the benefits of explicit risk management in complex projects, and gives concrete recommendations on how one can implement risk management effectively in a particular context. The contents of the report provide detailed information on the subject of project risk management methodology, tools and techniques to cope with the risks in complex EPRD projects.

These results would never been achieved without good supervision and support. Within HMC, I would like to thank my supervisor Machiel Penning for his support and advice during the stages of my project. Next I would like to thank Frank Lange and Sander Arens for giving me the opportunity to perform this project. Furthermore I would like to thank everybody within HMC that contributed to my interviews and questions over the past months.

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Bas Joustra
Delft, January 2010

Management summary

HMC's challenge: Effective risk management in complex EPRD projects

HMC is widely recognized as one of the world's leading companies in offshore transportation, installation and removal. A large part of the company's excellent reputation stems from its ability to respond to changing industry needs, market dynamics and its competitors. Recent trends in the offshore industry cause HMC to appeal to their adaptive ability more than ever as HMC is challenged by projects with a different risk profile: EPRD projects. In these projects, HMC takes on the role of main contractor for a much larger scope of work, illustrating the current shift of risk responsibility from client to contractor.

During the past five years, the workload of the PDR department has more than tripled since the NWH and Ekofisk EPRD projects were acquired in 2006/2007. However, the success of these projects is subject to many risks, stemming from the fact that the entire industry is still relatively inexperienced when it comes to the removal of the larger fixed platforms located in the North Sea. In current EPRD projects, HMC is responsible for the complete removal and disposal of large offshore platforms, as well as the management of all the project's subcontractors along the entire supply chain. This clearly sets the challenge for HMC to effectively manage the uncertainty and risks within these projects.

For the management of project risks, HMC has been using a formal PRM procedure for the past three years. However, there is still little known of the contribution of this process to the management of risks in practice. Consequently, this thesis focuses on the analysis of PRM at HMC and the improvement thereof to better cope with the risk profile of EPRD projects. It is argued that a review of HMC's PRM process is desired in the light of the company's current and future challenges. The aim of this thesis is to bring the knowledge of PRM and its application to an adequate level for the effective management of risk in complex EPRD projects. Consequently the thesis research question is: *How can the current HMC project risk management process be improved to best practice standards to cope with project risks and uncertainties in complex EPRD projects?*

Research Approach

Design science is the selected research paradigm, which combines both an interpretative and analytical perspective within a system's approach for the creation of knowledge (Van Aken, 2004). For the improvement of PRM, a pragmatic and solution-oriented approach is desired which focuses on both the "systematic" and "people" necessities for success. Case study research is considered to be a strong approach for the analysis of current PRM application within HMC, as it provides a multi-sided view of the problem situation in its real-life context (Perry, 1998)

- First, the drivers of risk within large EPRD projects have been explored from the perspective of HMC. Specific knowledge has been created on the importance and benefits of explicit PRM in complex EPRD projects.
- Secondly, literature on the subject of PRM has been reviewed to create an overview of the methodological principles of managing risk, as well as assessing the current "best practice" process for PRM.
- Thirdly, the HMC PRM process is explored in the light of best practice PRM standards. Information has been gathered through the analysis of both the NWH and Ekofisk EPRD projects. Results set out in this thesis are based on case interviews, desk research and the analysis of project-specific documents, system manuals and relevant literature.
- Fourthly, considerations for improving the effectiveness of the HMC PRM process are identified, based on best practice PRM processes, tools and techniques from literature.
- Finally, the thesis findings have been discussed in the light of the human dimension that influences PRM effectiveness and its implementation in practice.

Research results

The shift of risk responsibility and large project scope of EPRD projects creates the need for more explicit risk management activities. Together, the structural complexity, uniqueness and dynamics of EPRD projects cause managerial complexity, reducing the project manager's ability to predict, control and measure the outcome of the project as a whole. This makes it far more difficult for a single project manager to oversee, coordinate and control all the risks within an EPRD project.

In addition, there is a shift in risk balance between the client and contractor which causes a heightened risk responsibility for HMC in removals compared to installation projects. Removal projects are non-productive and therefore cost-driven instead of time-driven. As a consequence, the client is more interested in getting a low price and maintaining its reputation rather than that the project strictly adheres to previously set deadlines. The client has no direct financial interest in the "result" of the project, thus he will be prone to shift risks as much as possible to the contractor. HMC is faced with the challenge to keep the project within a predefined budget and schedule under constantly changing conditions, while not only managing their own risks but also those of their subcontractors.

Explicit PRM is considered to be of great value in EPRD projects because it significantly increases the change of project success (Cooke-Davies, 2005). PRM optimizes the probability that the project stays within the budgeted cost, the allocated schedule and the acceptance of the client. Effective management of risks focuses on identifying and responding to the uncertainties that really matter to the project as a whole, creating a better understanding of their existence and proactively changing their effects on project objectives. This creates more realistic project plans, and puts the necessary actions in place to cope with risks as the project proceeds. The complexity and dynamics of EPRD projects express the need for continuous PRM throughout the entire project lifecycle and a collective responsibility to implement risk response actions proactively.

Currently, HMC applies the same risk procedure to all projects with only little variation. There is no project-specific approach to the management of risk, in order to fit PRM implementation to the project's risk profile. For the more "simple" projects, the PRM process is often perceived as bureaucratic, while for the more complex and high-risk projects far more resources, efforts and rigorous controls are required. Best practice in the field of PRM prescribes to vary the amount of tools, techniques and risk reviews to fit the perceived level of risk within a particular project.

The current risk workshop takes three hours, while for the effective identification and assessment of risk in an extensive EPRD project one might need up to two days. This time is required to not only gather as much information as possible, but also ensure that all project parties discuss, agree and collaborate on these risks and their importance. The current HMC risk workshop lacks the means to stimulate "out-of-the-box" thinking and there is only little time for the rationalization, categorization and allocation of risks.

Next, it can be concluded that the current RMP procedure lacks a number of critical elements to ensure that the process moves from the analysis of risk towards taking effective actions in practice. There is often no clarity on who should take responsibility for the management of a single risk, therefore in many cases nobody does. It is therefore important to allocate each risk to a *single individual* that is considered to be the best risk owner.

At present, the project manager is the single person responsible for developing, implementing and controlling risk response implementation. There are no checks or controls in place to see if actions have been taken proactively and why risks have changed during the course of the project. Risk review sessions focus on updating the project risk register and model, rather than evaluating the chosen risk response strategy and implementation. Hence, the actual management of risk in practice is still performed in an implicit manner under the full responsibility of the project manager. Best practice PRM however prescribes that one should explicitly plan, report, monitor and control the implementation of risk response actions within the PRM process.

Thesis recommendations

Short term changes to PRM tools

Changing the tools and techniques applied in the current PRM process can quickly improve its effectiveness in practice. The following recommendations are made:

- **Change the Risk Workshop set-up:** It is recommended to increase the workshops duration from 1-3 hours to 1-2 days. Next, it is recommended to include a variety of identification techniques, specific tools for risk categorization and an explicit step that allocates each risk to a single risk owner.
- **Use meta-language for describing risks that clearly separates cause, risk event and effect:** It is recommended to describe each risk in a three-part structure that clearly separates a risks cause, event and effect. Correctly describing risks is critical for the development of effective responses.
- **Plan major review meetings at the start of every project phase:** In EPRD projects, there are several distinct phases for which a major risk review is required. Organizing a major risk review workshop at the start of each project phase will ensure that the risk register remains active and up-to-date
- **Include additional information on risk status and response actions:** Simply adding a few columns to the risk register that record the risk status, date and reason of exclusion can create an important change log that can be used to evaluate the effectiveness of the risk process.

Mid term changes to PRM process

A number of additional elements and steps are needed to increase the effectiveness of the PRM process. It is recommended to appoint an organizational risk sponsor to further develop the suggested changes to the PRM process. Next, it is recommended to evaluate this process in a pilot project before it is rolled out over the entire company.

- **Develop a project-specific Risk Management Plan (RMP):** PRM should be scalable, making it possible to vary the approach to fit the risk level of the project. Hence, it is recommended to include an explicit “initiation” step to determine the level of PRM implementation, documented in the project’s RMP.
- **Plan, allocate and report explicitly on risk responses and risk treatment actions:** It is recommended to explicitly allocate the responsibility for the development, implementation and control of risk responses actions to those people in the organization that are best placed to do so.
- **Assign an internal project Risk Champion for communication, control and monitoring:** A Risk Champion ensures that the actions and responses to risk are implemented with enough rigor and vigilance. A Risk Champion coordinates all PRM activities and reports directly to the project manager.
- **Capture Risk Knowledge and Risk Lessons Learned during project close-out:** Review the risk register, risk documents at the end of each project. Information on the risks that have actually occurred can be used to improve PRM on similar projects in the future.

Long Term change to PRM culture

Some changes to the PRM procedure will have to be part of a change program that takes place over a longer period of time until it becomes a cultural imperative of the organization.

- **Adequate use of range estimates in schedule and cost forecasting:** The conscious and subconscious factors that influence project forecasts and estimate can be minimized by using range estimates in project schedules and plans.
- **Planning-based Quantitative Risk Analysis:** Quantitative analysis on a project specific-risk model can be used to support risk response planning, estimate contingencies, compare alternatives, optimize resource allocation and show the effectiveness of planned responses and risk treatment actions.

Critical success factors for effective implementation of PRM in practice.

For PRM to become effective, it should form a central part of the culture and practice of HMC, which is something far more difficult to achieve.

- **Risk “mature” culture:** A risk mature culture is neither averse to risk, nor is it risk seeking. It is important to recognize the effect of personal and group risk attitude to influence PRM effectiveness.
- **Competent people:** Everybody should have the knowledge, skills and experience to recognize and manage risk at their level of responsibility. Continuous training is necessary to develop competence.
- **Top management commitment:** PRM requires strong leadership and commitment from top management to stimulate the application of the PRM process in practice.

Glossary of Terms and Abbreviations

The most used terminology and abbreviations are defined to acquaint the reader with their meaning.

Glossary of Terms

- Action Owner:** The person responsible for implementing an agreed risk action and reporting progress to the risk owner.
- Butterfly Matrix:** Two probability matrices presented alongside each other, with one showing the threats and the other showing the opportunities. Also known as the double PI matrix
- Eyeball Plot:** Output of an integrated time-cost quantitative risk analysis using Monte Carlo Simulation
- Opportunity:** A risk that would have a beneficial effect on the achievement of project objectives, such as improves safety and saved time or cost. Also known as a positive or upside risk
- PI Matrix:** Probability and impact matrix for used for qualitative risk prioritization
- Probability:** A measure of the likelihood for a specific risk. Probability may be expressed in qualitative terms (high, medium or low) or in quantitative terms (as a percentage or number in the range 0-1)
- Project Engineer:** The person responsible for the design of a technical part of the project
- Project Manager:** The person responsible for managing the project
- Project Management:** The application of knowledge, skills, tools and techniques to project activities to meet the project requirements
- Project Scope:** The features and functions that characterize a project or service
- Project Stakeholder:** Any person or party with an interest in the outcome of the project and/or an ability to exert influence
- Project Team:** The members of the project organization who are directly involved in project management activities
- Qualitative Risk Management:** Performing a qualitative analysis of risks to prioritize their effect on objectives, using PI matrices to classify risks in categories of high, moderate and low
- Quantitative Risk Management:** Measuring the probability and consequences of risks and estimating their implications for project objectives, using quantitative techniques such as Monte Carlo Simulation
- Risk:** Any uncertainty that if it occurs, would have a positive or negative effect on the achievement of on one or more objectives
- Risk Action:** This is an activity implemented in order to realize an agreed risk response. The risk actions and its associated cost are independent of the actual occurrence of the risk.
- Risk Analyst:** A specialist in risk management processes, tools, and techniques who may provide expert support in a project
- Risk Assessment:** The process of estimating risk probability and impact of identified risks, and comparing it against a defined risk acceptance threshold
- Risk Attitude:** A chosen mental disposition towards uncertainty, influenced by perception
- Risk Breakdown Structure:** A hierarchical framework presenting possible sources of risk, used to structure risk identification and qualitative risk assessment.
- Risk Champion:** The person responsible for facilitating the risk management process on a particular project
- Risk Evaluation:** See risk assessment
- Risk Event:** An uncertain discrete occurrence that, if it occurs, would have a positive or negative effect on the achievement on one or more project objectives
- Risk Driver:** An uncertain factor that exerts a significant influence over the overall outcome of the project
- Risk Management:** The structured process of taking appropriate decisions and implementing actions in response to known risk events and overall project risk
- Risk Management Plan:** A planning document that records the parameters of the risk process for a particular project, including: the cope and context of the risk assessment, the objectives, methodology, tools, techniques to be used, roles and responsibilities and reporting requirements.
- Risk Model:** A mathematical representation of a project that can be used as a basis for quantitative risk analysis
- Risk Owner:** The person responsible for ensuring that an appropriate risk response strategy is selected and implemented
- Risk Profile:** The exposure of project stakeholders to the consequences of variation in project outcomes. Also known as the sum of individual risks, estimated through quantitative risk analysis
- Risk Register:** A record of all risks from the risk management process for a particular project
- Risk Response:** A strategy for determining what should be done with a risk. This leads to specific risk actions to deal with individual risk events or sets of related risks.
- Risk Response Planning or Risk Treatment:** Process where appropriate risk response strategies are developed, risk actions generated and risk owner and actions owners are nominated
- S-Curve:** A cumulative probability curve produced from a quantitative risk analysis using Monte Carlo Simulation
- Stakeholder Analysis:** The process of determining the degree of interest, influence, and attitude of stakeholders toward a particular project
- SWOT Analysis:** strengths, weaknesses, opportunities, threats analysis
- Threat:** A risk that would have an adverse effect on the achievement of project objectives, such as injury, damage, delay, or economic loss. Also known as a negative or downside risk

Abbreviations

ABB.	DESCRIPTION – SUBJECT OF EPRD PROJECT	ABB.	DESCRIPTION – SUBJECT OF PRM
AFD	AF Decom	AIRMIC	Association of Insurance and Risk Managers
BP	British Petroleum	ALARP	As Low As Reasonably Possible
CBS	Cost Breakdown Structure	ALARM	National Forum for Risk Management in public sector
COPSAS	ConocoPhillips Skandinavia AS	AMA	American Management Association
COP	Cessation of Production	APM	Association for Project Management
DECC	Department of Energy and Climate Change	ATOM	Active Threat and Opportunity Management
DCV	Deepwater Construction Vessel	BSI	British Standards Institute
EIU	Economist Intelligence Unit	COSO	Committee of Sponsoring Organizations
EPIC	Engineering, Procurement, Installation & Commissioning	CSA	Canadian Standards Association
EPRD	Engineering, Preparations, Removal and Demolition	ERM	Enterprise Risk Management
FPSO	Floating Production Storage and Offloading	HAZID	Hazard Identification
FM	Force Majeur	HAZOP	Hazard and Operability Study
GOM	Gulf of Mexico	IEC	International Electro-technical Commission
GBS	Gravity based structure	IEEE	Institute of Electrical and Electronic Engineers
HMC	Heerema Marine Contractors	ICE	Institution of Civil Engineers
HSE	Health, Safety and Environment	IRM	Institute of Risk Management
IMO	International Maritime Organization	ISO	International Organization for Standardization
IMCA	Institute of Marine Contractors	JSA	Japanese Standards Association
ISO	International Organization for Standardization	M_o_R	Management of Risk (OCG)
IT	Information Technology	OCG	Office of Government Commerce
LDC	London Dumping Convention	OSPMI	Office of Statewide Project Management Improvement
NOIA	National Oceans Industries Association	P&I	Probability and Impact
NWH	North West Hutton	PMBok	Project Management Body of Knowledge (PMI)
OBS	Organizational Breakdown Structure	PMI	Project Management Institute
OSPAR	Oslo and Paris Convention	PRAM	Project Risk Analysis & Management (APM)
P&A	Plugging & Abandonment	RAMP	Risk Analysis and Management for Projects (ICE)
PC	Project Controller	RBS	Risk Breakdown Structure
PCB	Poly Chloor Bifenyl	RIMS	Risk and Insurance Management Society
PDR	Platform Decommissioning and Removal	RISMAN	Risicomanagement en Risicoanalyse voor Projecten
PE	Project Engineer	RMP	Risk Management Plan
PES	Project Execution Schedule	RSKM	RISK Management (SEI)
PM	Project Manager	SEI	Software Engineering Institute
PMS	Project Master Schedule	SWOT	Strengths, Weaknesses, Opportunities, Threats
POST	Parliamentary Office of Science and Technology		
PRM	Project Risk Management		
PSS	Project Summary Schedule		
PRD	Project Related Documents		
QESH	Quality, Environment, Safety and Health		
QRA	Quantitative Risk Analysis		
RM	Risk Management		
ROV	Remotely Operated Vehicle		
SSCV	Semi Submersible Crane Vessel		
T&I	Transport & Installation		
TLP	Tension leg platform		
TOE	Technical, Organizational and Environmental		
UNCLOS	United Nations Convention on Law Of the Sea		
UKCS	United Kingdom Continental Shelf		
WBS	Work Breakdown Structure		

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Chapter 1

*"When our world was created,
nobody remembered to include certainty"*

Peter Bernstein

"Success is foreseeing failure"

Henry Petroski

1.1 Rise of Risk Management

1.2 HMC's Challenge

1.3 Research Aim

1.4 Report Structure

1. Introduction



Successful businesses and projects are all about taking risk. Without risk no development, no innovation and in the end, no reward. However in today's volatile times it has become increasingly important to be fully aware of the risks we face and develop effective ways to cope with them. The worldwide credit crisis has forced many companies to sit up and rethink the importance of risk management as a strategic element of their businesses (RIMS, 2009). *Risk management* (RM) offers a way of making the future more visible today, assisting decision makers in making better decisions in spite of the future's inherent uncertainty.

To Heerema Marine Contractors (HMC), managing risk has always been an integral part of their core business as one of the world's leading marine heavy-lifters. Yet, the world around HMC is rapidly changing as HMC is entering new markets and faces a shift of risk responsibility from client to contractor (Heerema, 2009). As a result, project success progressively requires proper attention to effective RM practice, which in most cases is still performed in an implicit manner.

Therefore, this thesis project investigates the current HMC risk management practice and focuses on the risks associated with large decommissioning projects. Best practices in the field of project risk management (PRM) are used to improve HMC's ability to effectively manage these complex projects.

1.1 Rise of RM importance in today's business culture

Only few would disagree that life is risky and for many people risk might even be the element in life that makes it worthwhile. However, inadequate risk taking is dangerous as it may lead to unexpected and in most cases disastrous consequences. This has led to the recognition that managing risk is important to all, whether it is in business or in everyday life. This maxim holds a strong implication in the field of project management (PM), where many decisions have to be made in the face of uncertainty. Not surprisingly, many projects fail because of ineffective risk taking, causing major budget and schedule overruns. According to study by Flyvbjerg among 258 large engineering projects, 9 in 10 projects of the past 70 years have experienced a cost overrun (Flyvbjerg, 2003).

Consequently, risk management is widely recognized as an essential part of effective project management, where it can assist the project manager to mitigate against both known and unanticipated risks. For projects to become successful, one should not limit its view to past accomplishments, but acknowledge the future's inherent uncertainty and its potential to affect project objectives. It is therefore crucial for every business to keep a "*risk mature*" management culture as risks are inevitable, leading to the simple truth that the sooner they are dealt with, the better. Empirical research by Cooke-Davies (2005) gives that effective PRM is the single most influential factor in project success. Detailed analysis of over 80 projects shows that projects are

completed on average at 95% of the initial plan when “*fully adequate*” PRM is implemented, in contrast to an average of 170% when PRM implementation is poor (Cooke-Davies, 2005).

The relevance of risk management as a strategic element of successful businesses is further emphasized by our rapidly changing financial climate. The worldwide economic crisis has quickly moved RM up the agenda of many organizations. Especially in the financial sector the management of risk has become a “hot topic” of conversation, as over 60% of the world’s financial institutions indicate that poor RM practice has fueled today’s economic decline, whether or not it may hold a significant contribution to its existence in the first place (EIU, 2008). However this revelation does not constrain itself to the world’s exposed banks, rather it emphasizes the continuous struggle of many professional organizations to effectively manage their risks. Accordingly, RM receives a lot of attention and is thoroughly studied and propagated by research institutes and management consultants. But in spite of these efforts, very few organizations seem to practice and implement PRM, let alone do so effectively (Taylor, 2005; Cooke-Davies, 2005; Pender, 2001). A longitudinal project management analysis over the years 1998-2003, initiated by the Project Management Institute (PMI), shows that organizations consistently fail to apply RM across projects (Mullaly, 2006). Furthermore, results from a recent empirical study among 142 project managers indicate that PRM is the least applied PM practice across a large variety of industries, independent of the project’s context, size or duration (Papke-Shield et al., 2009). Other studies within the Construction industries (Kartam, 2001; Baker et al., 1999), IT project sector (Taylor, 2005) and Utilities sector (Van Wyk et al., 2008; Elkingston, 2002) confirm these findings, giving that there exists an apparent gap between the theory and the effective application of PRM in practice. Because despite a shared view on the importance of PRM, many project managers and risk practitioners experience problems when they try to make it work in practice, pointing out that PRM is not producing the expected and promised results. “*The main challenge we are facing in managing our risks effectively is to move from theoretic guides and handbooks to effective practice*” (Murray-Webster and Simon, 2008).

The tension between growing PRM importance and the difficulty to perform PRM effectively in practice is also present at one of the world’s leading companies in the marine contracting industry, Heerema Marine Contractors (HMC). As a contractor, HMC executes the most challenging and complex projects in the world. Hence, there is no doubt that PRM is central to HMC’s core business, as some even say that HMC is in the business of taking risk.

Still, PRM within the marine contracting industry is only “*scarcely out of the egg*” (Vrijling, 2008). HMC’s organization is built on over 50 years of experience in offshore lifting, however their systematic approach for managing project risk is no more than three years old. Besides, there is little known of the actual benefits of this process in HMC’s projects. And as the world around HMC is rapidly changing, so does its need to address these risks proactively and improve PRM practice to the full range of possibilities it has to offer.

1.2 HMC’s Challenge: Effective risk management in complex EPRD projects

HMC is widely recognized as one of the world’s leading companies in offshore transportation, installation and removal. By serving the oil and gas industry for over half a century, HMC has grown from a small construction company into a multimillion business with over 850 employees worldwide. Currently, HMC operates three of the world’s largest “*Semi-Submersible Crane Vessels*” (SSCVs) with a dual-crane feature capable of lifting 8.100 to 14.200 tons. These massive cranes have set many industry records for their lifting capabilities, contributing to HMC’s excellent reputation as a marine heavy-lifter (HMC, 2007).

A large part of this reputation stems from the company’s ability to constantly respond to changing industry needs, market dynamics and its competitors. Having the nerve to explore new opportunities, stimulate innovations and take on record breaking projects significantly added to

HMC's success and development over the years. Risk management is therefore something deeply imbedded in HMC's organizational culture and project management systems.

However more recent trends in the offshore industry cause HMC to appeal to their adaptive ability more than ever. HMC finds itself in a state of transition, gradually differentiating its core business activities by entering new markets and taking on bigger and more complex projects.

Currently, HMC's reputation of high standards and technological excellence is challenged by projects with a different risk profile, e.g. EPIC¹ and EPRD² projects. In these projects, HMC is no longer a subcontractor, but has the role of main contractor over a much larger scope of work. This illustrates the trend of shifting risk responsibility from client to contractor, stressing HMC's need to address and manage risk proactively (Beckham, 2008).

The financial crisis further emphasizes the importance of effectively managing risk, as cost efficient performance has become evident on all projects. Many investments in offshore platforms are postponed and profit margins are shrinking. Besides, HMC's vessels are nearing the end of their productive lifecycle, resulting in ever increasing maintenance costs to keep them up and running. The concept of fleet renewals will only be probable when HMC improves its results long term over and above current performance. Consequently, HMC needs to improve its efficiency as an organization in managing the increased complexity in their current projects. As HMC's owner and CEO Pieter Heerema clearly points out: *"Without such gains, any long term strategy is doomed"* (Heerema, 2009).

These developments have elevated the importance of a relatively new and promising market area to HMC: *the offshore removal market*. At present, removal projects are of particular interest to HMC as they provide a large part of the company's financial backlog. The workload of the Platform Decommissioning and Removal (PDR) department tripled in the past five years, when HMC acquired the North West Hutton (NWH) and Ekofisk EPRD projects in 2006/2007. As these removal giants ensure work for HMC during the rough economic climate of today, their success however is subjected to many risks and uncertainties.

For a large part, these risks stem from the fact that the industry is still relatively inexperienced when it comes to the removal of the larger fixed platforms located in the North Sea (Cunningham, 2007). Furthermore, the responsibility that HMC has in current EPRD projects in addition to their uniqueness, dynamics and complexity gives a clear cut example of the challenge HMC faces in the coming years. The lessons learned from these first EPRD projects offer a unique opportunity to HMC to improve their overall performance in managing risk. This research project therefore focuses on PRM in complex EPRD projects, as it provides an interesting case for exploring the gap between PRM theory and practice. With the application of best practice PRM HMC can ensure effective decision-making and simultaneously improve their efficiency in doing so. This supports HMC's general objective to improve managerial efficiency under changing conditions.

1.3 Research objective

At present HMC uses a PRM process on all its projects for the past three years (HMC, 2006). However, there is little known of the contribution of this process to the effective management of risks in current EPRD projects. Review and improvement of HMC's PRM system is desired in the light of the challenges HMC faces in the coming years.

Consequently, the aim of this thesis is to create more insight in current PRM practices and the improvements that can be made to cope with the risks in complex EPRD project. In other words, exploring *what is currently done* and *what actually works*. The research focuses on improving current PRM practice in large EPRD removal projects, using the NWH and Ekofisk EPRD projects as a case

¹ Engineering, Procurement, Construction, Installation

² Engineering, Preparations, Removal and Disposal

study. The issues described in the preceding sections provide the starting point for this research project and result in the following main research objective:

Develop an approach to improve the current HMC project risk management process to best practice standards to cope with project risks in large EPRD decommissioning projects.

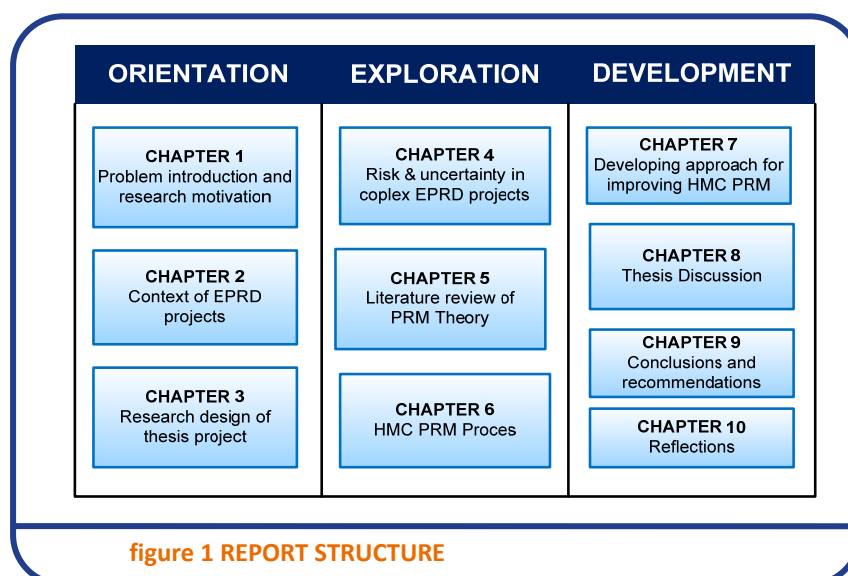
To reach the main research objective, two general areas of research are consulted: The *management of complex projects* and *project risk management*. For the improvement of HMC's PRM practice, findings from both areas are integrated.

On one hand, research will aim at providing an overview of the issues in managing large EPRD projects and the specific risks that affect this kind of projects. What makes large removal projects different, challenging and complex in comparison to the more conventional installation projects? This will create a better understanding of the desired level of PRM implementation in complex EPRD projects. Where the experience and lessons learned from the first large removal project (NWH) may be crucial for the success of future EPRD projects.

On the other hand, this study will focus on identifying best practices and requirements for the effective implementation of PRM. Comparing these findings with the current process implemented at HMC will make it possible to explore the congruence between PRM theory and its application in practice. As a result, quick wins can be identified for improving the effectiveness and efficiency of HMC's PRM strategy.

1.4 Report Structure

The outline of the research project is shown in figure 1. The *orientation* on the research objective is outlined in chapters 1 (introduction), 2 HMC's expertise in the context of decommissioning projects and 3 (research questions and overall research approach). Results of specific research on *exploring* HMC's PRM process are stated in chapters 4 (conclusions from research on the risks in large EPRD projects), 5 (review of project risk management literature) and 6 (where the current HMC risk management practice is analyzed and compared to best practices from literature). Finally, the *development* of possible improvements to HMC's PRM approach is outlined in chapters 7 (developing an approach for managing risk in complex EPRD projects) and 8 (the discussion on the effectiveness of this approach in a practical context). The report ends with the study's conclusions and recommendations, together with a critical reflection on the research performed (Chapter 9 & 10).



Chapter 2

"The main industry's technical challenge is to remove the Northern North Sea steel jackets"
Jan Groot, Project Manager HMC

"The big question is not: How much risk is acceptable? It is: How do we frame the process for choosing the best decision option"
S. Kaplan

2.1 HMC's Expertise in the offshore industry

2.2 Decommissioning market North Sea takes off

2.3 HMC takes on new role in first EPRD projects

2. Context of EPRD projects



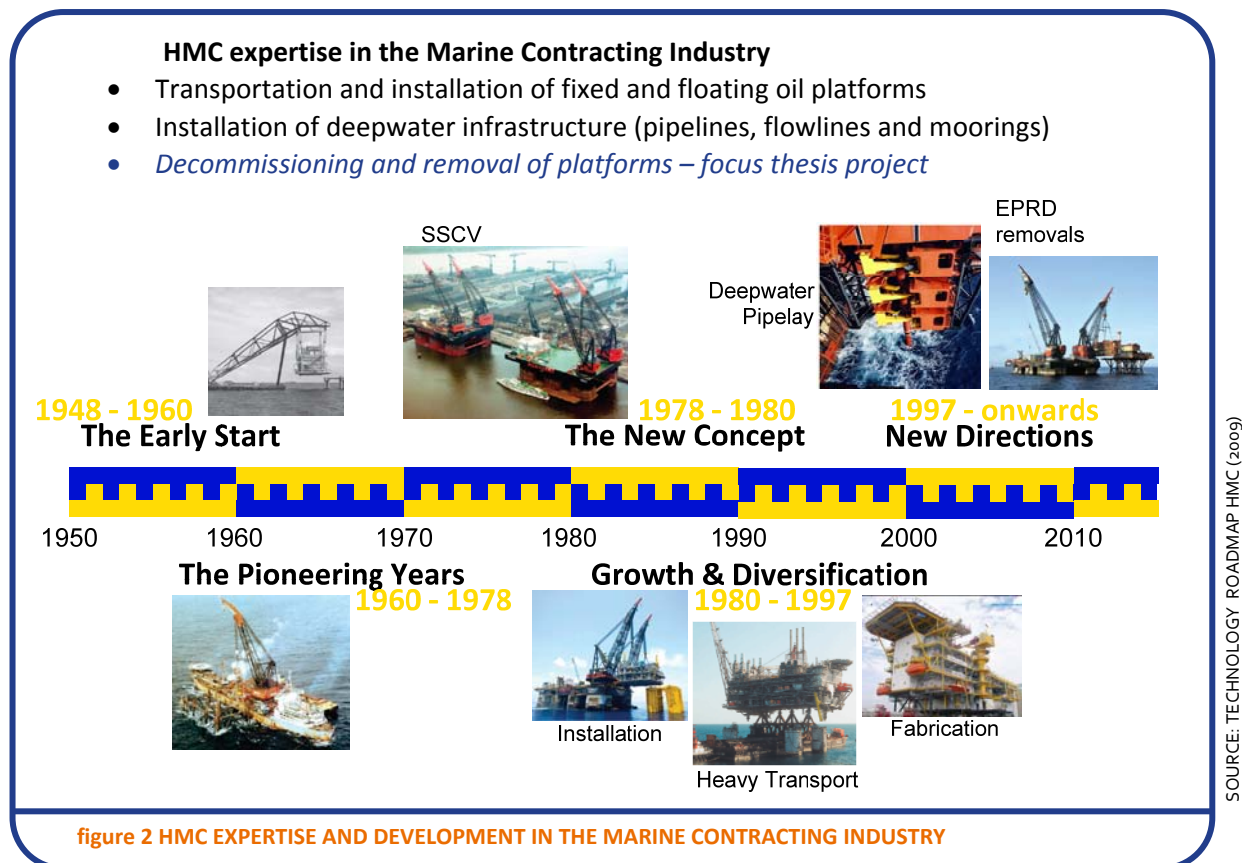
The aim of this chapter is to give a general overview of the context of EPRD projects, the market for large decommissioning projects, as well as the expertise of HMC as a company within this market. In the light of past decommissioning experience and future market projections, the general challenges of EPRD projects will be discussed from HMC's perspective. The findings discussed in this chapter are the result of an extensive literature analysis on the subject of decommissioning and removal of large offshore platforms. A more detailed description of the topics discussed in this chapter can be found in the appendices A till H. Specific information on HMC's expertise and experience in performing large offshore removals stems from explorative interviews with HMC personnel (Interview x-x, see appendix N) and desk research of HMC's internal documents.

2.1 HMC's expertise in the offshore industry

Starting operations in Venezuela in 1948, HMC gained relevant experience with the installation of drilling platforms in the North Sea during its pioneering years (1960-1978). The industry's need for more capacity and stability in heavy weather conditions made HMC introduce the world's first "*Semi Submersible Crane Vessels*" (SSCVs) in 1978, which enabled the construction of fewer and heavier platform modules. This meant that installations which before had required the entire summer were completed by HMC in less than six weeks, leading to an enormous financial advantage for HMC's clients. Currently, HMC operates three of the world's largest SSCVs with a dual-crane feature capable of lifting up to 8.100 tons (Balder & Hermod) and 14.200 tons (Thialf).

For the last decade, offshore development increasingly turned its focus to deepwater constructions in more remotely located areas. Consequently, HMC has transformed the SSCV Balder into an advanced deepwater construction vessel (DCV), capable of performing construction and pipe-lay activities down to a water depth of 3.000 meters. This allowed HMC to enter the fast growing pipe-lay market, becoming a major player in realizing deepwater facilities and subsea infrastructure.

However more recent developments in the marine contracting industry have driven HMC's vessels into relative unexplored waters, as the offshore decommissioning market takes off. Many of the North Sea oil and gas fields are now entering their mature phase, and so the prospect of widespread decommissioning is rapidly closing in. From the perspective of the platform's operators, decommissioning implies a costly aftermath one likes to postpone as much as possible, but for HMC a promising new market area is starting to reveal itself. During the past decade, HMC therefore continued to differentiate its product portfolio and has made offshore decommissioning part of its company's expertise (see figure 2).



At present, the removal market is of particular interest to HMC as offshore investments are rapidly declining as a result of the financial crisis. In the past 5 years, the workload of HMC's Platform Decommissioning and Removal (PDR) department has more than tripled when the North West Hutton and Ekofisk EPRD removal projects were acquired in 2006/2007. Currently, these projects provide a large part of the company's financial backlog, giving a clear implication of the relevance of this growing market area to HMC.

This thesis focuses on improving PRM practice in large decommissioning projects, as it is expected that this market section will grow rapidly in the coming years. HMC will quickly need to acquire the skills and knowledge to execute these complex projects in a safe and cost efficient manner. This will not only strengthen HMC's market position but may be crucial to its survival in today's economically turbulent times.

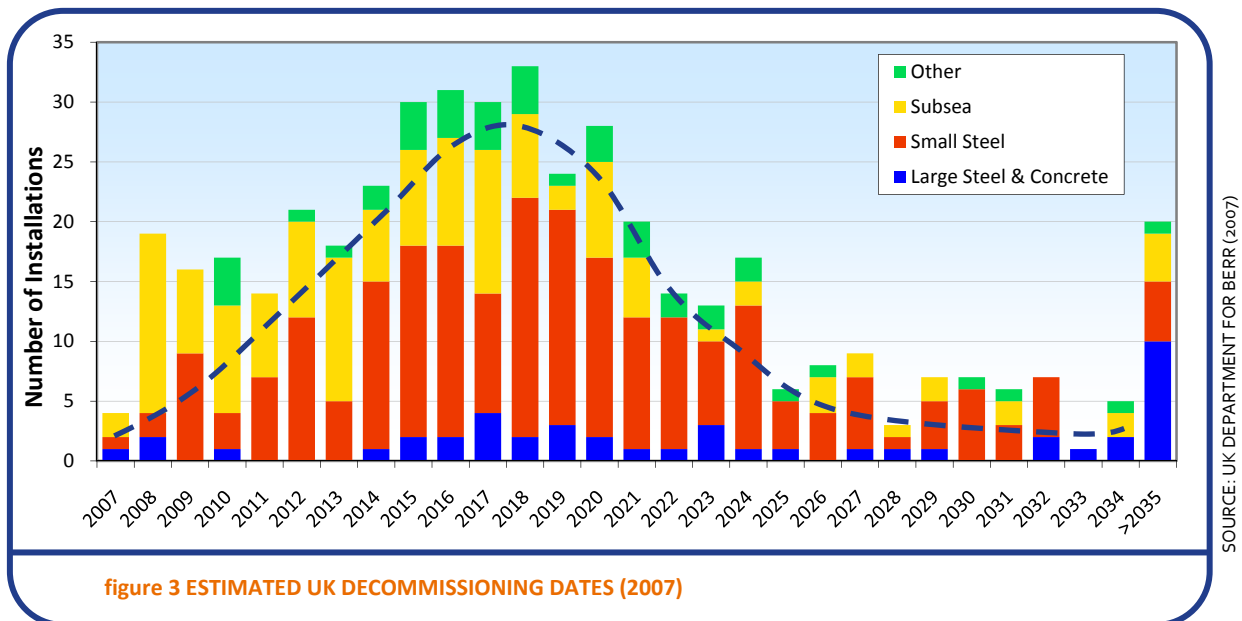
2.2 North Sea decommissioning market takes off

Two decades ago, the entire petroleum industry regarded the decommissioning and removal of offshore installations as a problem for the very distant future. But as we continue into the 21st century, first and second generation offshore facilities installed in the North Sea during the '60s and '70s, are quickly passing into retirement (Cunningham, 2007).

Today, about 7500 offshore platforms exist worldwide, located on the continental shelves of 53 countries (GOPA-consultants, 1996). About 4,000 of these are situated in the Gulf of Mexico, 950 in Asia, 750 in the Middle East, 650 in Africa and almost 500 platforms in the North Sea (see appendix B). Eventually, all of these platforms will have to be decommissioned and removed.

However, in the global context of the oil and gas industry, decommissioning is nothing new. To this date, most of current decommissioning knowhow comes from projects executed in the relatively shallow waters of the Gulf of Mexico (GOM), where approximately 2.000 small structures have already been removed (Pulsipher, 2001; O'Connor 2004; Lakhal, 2008). However, these are light weight structures (<5.000 tons jacket weight) in comparison to the North Sea platforms that have to withstand constant heavy weather in much deeper waters. Therefore the industry is in no doubt that

the biggest challenges are yet to come as they imagine the complexity and difficulties of removing the larger structures (>10.000 tons jacket weight) located in the northern part of the North Sea. So far, a total of 40 platforms have been removed in the North Sea, indicating the huge difference in removal experience compared to the GOM (O'Connor, 2004). But as market forecasts indicate that the estimated number of removals will grow rapidly over the next 20 years, attention has shifted to the seas of Europe (see figure 3).



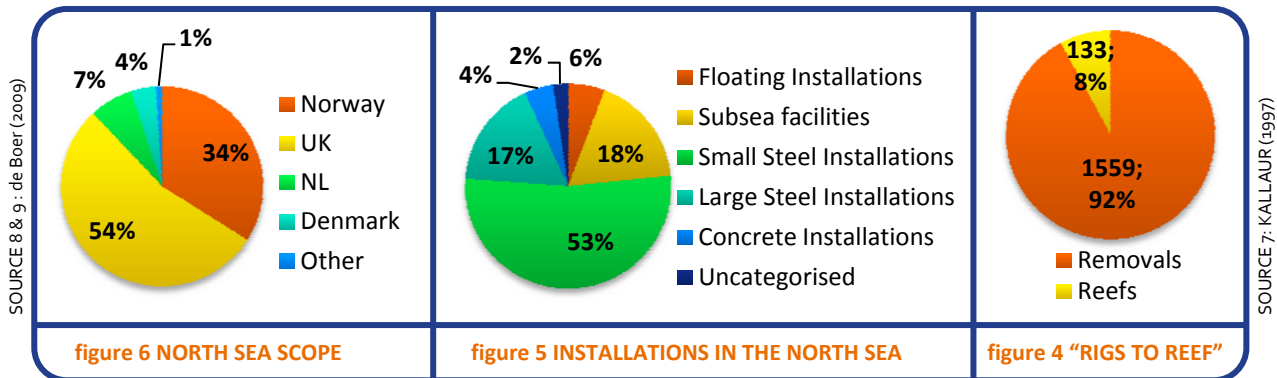
The focus on North Sea removals is further emphasized by estimations of the worldwide decommissioning cost (see appendix C2). While only 5% of the world's platforms are located in the North Sea, they will cover over 50% of the worldwide cost for their removal, estimated at in between 30 to 60 billion USD. (Izundu, 2006; Bradbury, 2008). Recent calculations of the UK DECC value the total cost at 20 billion USD for the decommissioning of the UKCS platforms alone (Mayo, 2009). In addition, the European Commission indicates that over half of this amount will be spend in the next 20 years, of which approximately 88% is accounted for the removal of the heavier fixed structures located in the UK and Norway (GOPA-consultants, 1996). HMC's focus in the emerging removal market will be on these heavier fixed structures located in the northern part of the North Sea, as they may require heavy lift vessels for their removal and are therefore of significant value to HMC.

Yet the scope and complexity of the challenge HMC faces can only be fully understood when taken notice of the complicated body of national and international regulations (see appendix D). Because as the design of offshore structures evolved rapidly during the 1970s and 1980s, the legislation governing their eventual removal changed along with it. Especially during the last 30 years, new guidelines have emerged that recognize the need to protect the environment, navigation, fishing and other uses of the sea. Global legislation is set by the 1982 UNCLOS³ and 1989 IMO⁴ guidelines, which indicate that all structures standing in less than 100 meters of water with a weight of less than 4.000 tons will have to be removed completely. This clearly sets the worldwide scope for offshore decommissioning, but merely justified from the perspective of navigational safety. The UNCLOS is less clear about how one should dispose of the removed installation. The "dumping" of wastes and other matters in the world's oceans is regulated by the 1972 London Convention, declaring that it is possible to dispose offshore structures at sea when one selects an adequate disposal site and analyzes the potential effects on the environment. In this line of reasoning, leaving platforms on the

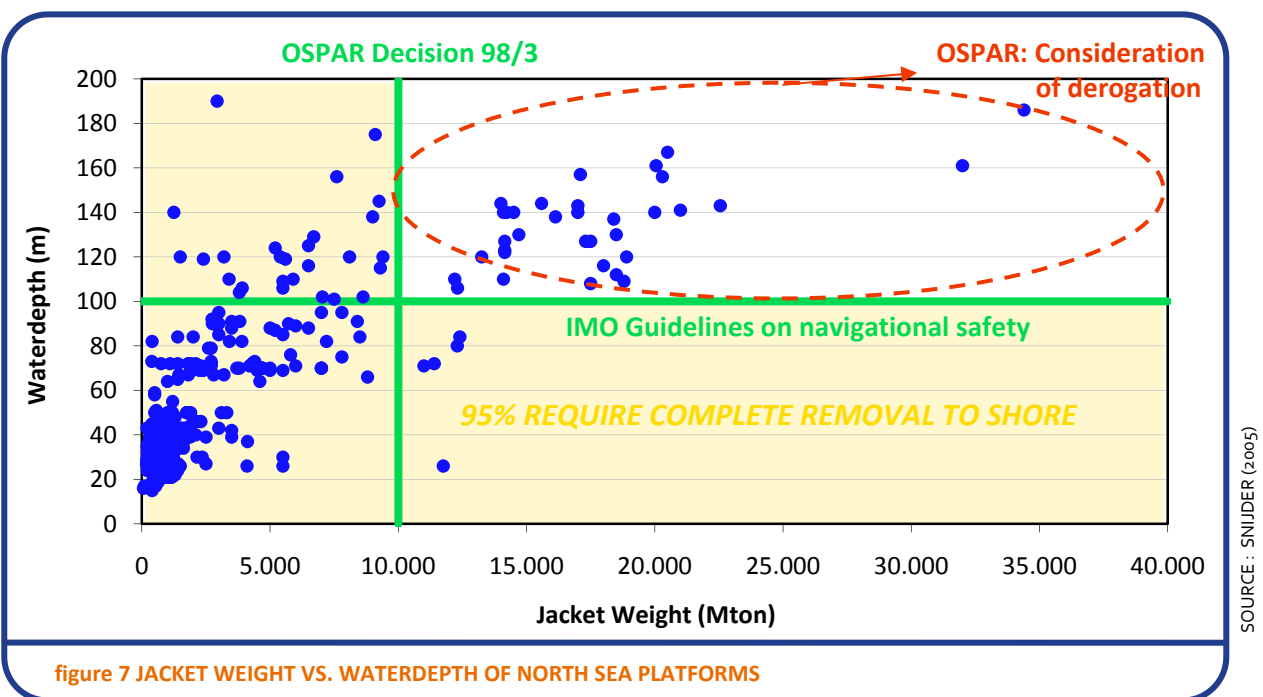
³ United Nations Convention on the Law of the Sea

⁴ International Marine Orgniazation

seabed to form artificial reefs in not considered as dumping and hereby allowed, which has led to the “Rigs to Reef”-program in the GOM. Consequently, a total of 133 steel jackets have been toppled on the seafloor, currently fulfilling their new purpose as diving sites and fishing spots (see figure 4).



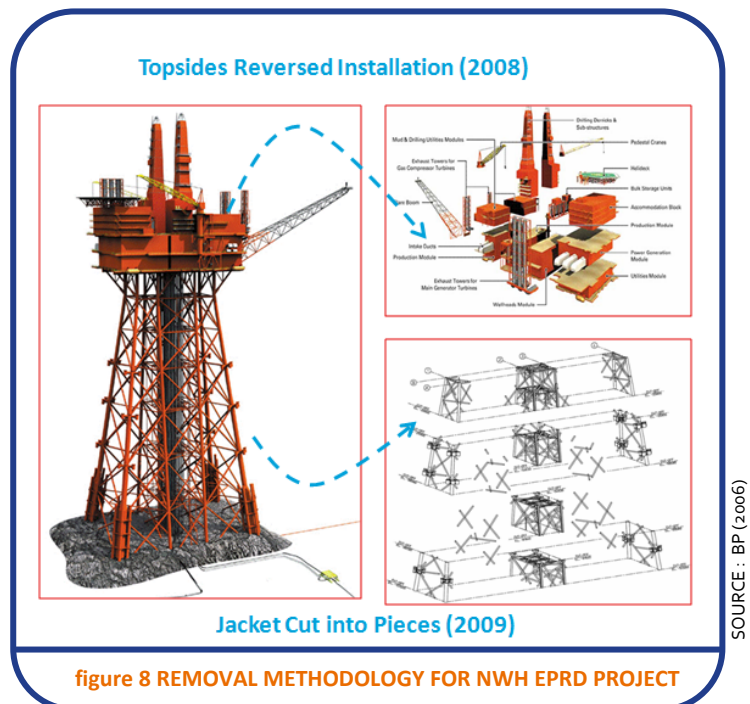
However, there will be no similar fate for the North Sea platforms (see figure 5 and figure 6), as a direct consequence of the Brent Spar incident in 1995. The Brent Spar was a 14.500 ton floating buoy operated by Shell in UK waters. Taken out of operation in 1994, Shell proposed that the disposal of this oil platform in the Atlantic Ocean would be the “*optimal course of action with proper regard for the environment, other uses of the sea, safety and cost considerations*”. Next, Greenpeace launched an offensive campaign as a result of which the Brent Spar became the centre of media attention, eventually leading to a consumer boycott that made Shell move the buoy to Norway for re-use purposes (POST, 1995; Lofstedt and Ortwin, 1997). The controversial case of the Brent Spar made the OPSAR⁵ Commission release the 1998 OSPAR Decision 98/3 that expressed a tightening of the IMO guidelines, together with the absolute “*prohibition of dumping disused offshore installations at sea*” for all platforms in the North-East Atlantic. Possible derogations to this rule are very hard to achieve and must be agreed on by all OSPAR Contracting Parties (see appendix D.2.1). In essence, even the larger fixed jackets (>10.000 tons) will have to be removed completely and disposed off onshore. This sets the large and complex scope of work for HMC, as in the end it falls to the contracting industry to develop ways for the safe and sound removal of these structures (see figure 7).



⁵ Oslo and Paris Conventions for Protection of the Marine Environment of the North-East Atlantic

All the approximately 600 North Sea oil platforms that need to be removed under the OSPAR Decision were designed at a different time and to suit the demands of specific field conditions, which resulted in a wide range of platform designs. Due to this variety, it is almost impossible to develop a single tried and tested method for their eventual removal. Therefore every platform poses a specific challenge and requires the development of a new “removal concept”. In addition, new techniques for safe and environmentally sound cutting at greater depths will have to be developed, and the deteriorated state of the platforms implicates a higher change of unpredicted and potentially dangerous events. Platform operators are determined to avoid these dangerous events, or any problems like Shell experienced with the removal of the Brent Spar. Not surprisingly, protecting the company’s reputation is on top of the project’s priorities list, next to safety, environmental damage, cost and duration. Moreover, environmentalists like Greenpeace are following decommissioning projects closely, which stresses the need to carefully assess and study each option for removal.

But as operators have spent most of their time and resources on the installation and production of their platforms, there is little known on the best method for removal. At present, concepts for lifting the platform as a whole with special designed one-lift vessels are being examined (Van Velzen, 2007). But to date these concepts have never been executed and most of these giant “one-lifters” only exist on blueprints. Consequently, the common strategy to remove a fixed platform is by “reversed installation”. This means that the platform’s topside is cut up into the original pieces (or modules) of which it was constructed. That way, one can be sure that removal is technically feasible, but it makes the offshore operations much more dangerous as all of these modules are connected by thousands of electrical wires and pipelines contaminated with flammable materials. Each module therefore needs to be “hooked-down” and carefully prepared offshore, before it can be lifted onto barges and transported to the shore for recycling (see figure 8).



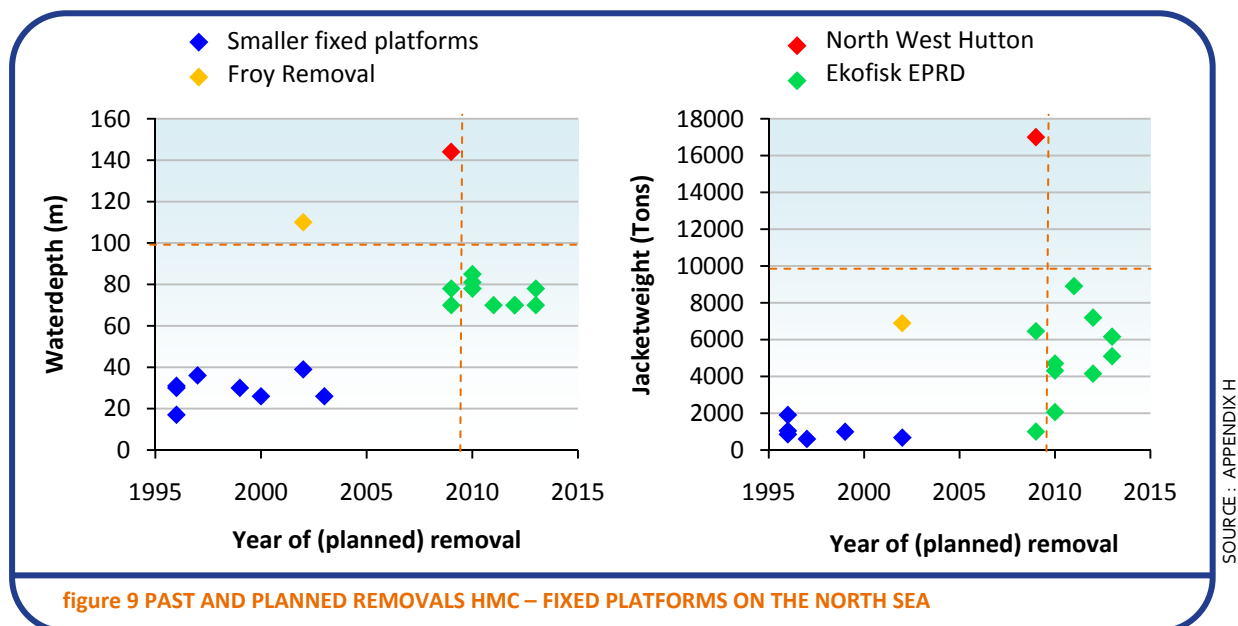
However the biggest challenge considered with decommissioning projects in the North Sea is the removal of the “jacket” structures (steel supporting structure of the platform, see appendix E). These giant steel structures have been constructed on land and then transported onto a large barge to their final locations. Next, they have been carefully “launched” into the water, by filling the jacket’s legs with water in a controlled manner. This means that for removal, the jacket structure will have to be cut up into smaller pieces. However up until now there are no clear guidelines on how to cut such a structure into manageable chunks, while at the same time keeping the structure from collapsing under its own weight.

The current removal methodology for large North Sea platforms is in favor of HMC, as they are the ones that have installed many of the platforms and therefore have a lot of knowhow on how to lift the original platform modules. But this also means that HMC will have to acquire new skills in platform hookdown, subsea cutting, ROV handling etc., as many of these removals are being sold as a total package, introducing the concept of “EPRD projects” (see appendix G).

2.3 HMC takes on new role in the world's first EPRD projects

While the industry as a whole is very inexperienced when it comes to offshore decommissioning, HMC has already been removing platforms since 1985. Until 2008, HMC had removed 10 fixed platforms from the seabed of the North Sea, next to around 15 single topsides (see appendix H). Most of these platforms were relatively easy to remove as they are located in shallow waters (20-40m of water depth). Besides, these platforms were merely 10-20 years old and already fully prepared for their removal. HMC could simply lift these structures as a whole, without any complex cutting or hookdown activities (Interview 2, appendix N).

Consequently, HMC still lacks the experience when it comes to the removal of the larger fixed platforms located in the northern part of the North Sea (see appendix B, H). These platforms are standing in between 80-150m of water, weighing up to 10 times as much as the structures HMC has removed so far. There is therefore no doubt that the greatest challenges are yet to come as HMC has taken on the removal of the NWH platform (2006) and the 9 Ekofisk platforms (2005), see appendix I.2. The NWH platform is planned to be removed by the Hermod in the summer of 2008 and 2009. This platform is unique to the entire industry, standing in 144m of water and weighing almost 40.000 tons in total. The 9 Ekofisk platforms are scheduled for decommissioning in the period of 2009-2013, using both the Thialf and the Hermod. With a water depth of 80m on average, these platforms are considered to be equally challenging as the NWH platform, adding the fact that they have already been abandoned for almost a decade and are therefore in a terrible state.

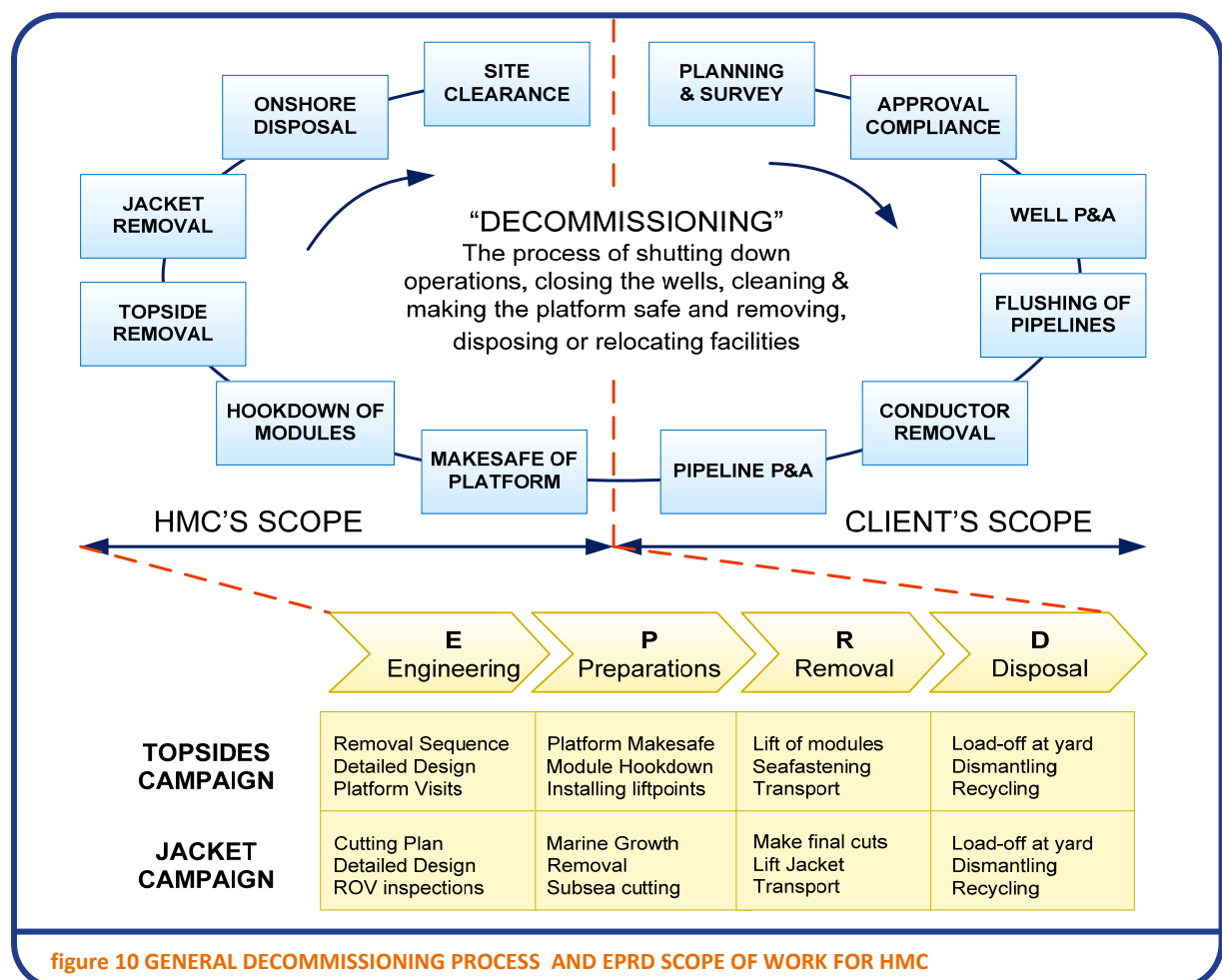


The charts in figure 9 show the change in the platform's size and weight that HMC faces in the coming years, compared to their history of removal projects. The NWH project clearly stands out, and is considered to be one of the most challenging removal projects the world has seen so far. And as the Ekofisk campaign starts right after the NWH project, there is almost no time for the implementations of lessons learned. The challenge HMC faces does not only stem from the physical features of these platforms, rather it is expressed through the responsibility HMC has taken on as the project's "main contractor". Because instead of just lifting and transporting the platforms to shore, HMC has signed both NWH and Ekofisk as *EPRD projects*, which makes HMC responsible for both the *Engineering, Preparations, Removal and Disposal* phases of a large removal project.

For a large fixed platform like NWH, the entire process of decommissioning and removal may take as long as 10 years (see appendix G). Up to 5 years in advance of the actual removal operations, the

platform operators will have to issue a “Cessation of Production” permit (COP) to the government, hereby starting the extensive process for approval of the decommissioning program. This program consists of several activities that need to be undertaken before the platform can actually be removed. A typical decommissioning program starts with the plugging and abandonment (P&A) of the platform’s wells, after which all the pipelines can be drained and flushed. In most cases, the platform’s operator is held responsible for plugging the pipelines connected to the platform. When all the external conductors and pipelines have been removed, the platform is completely cut off from its surroundings and ready for removal (see appendix F).

However, the most complicated job has yet to begin; the actual removal and disposal of the physical platform structure. In previous projects, HMC was subcontracted for the lifting and transporting of already prepared modules. But in current projects, HMC is responsible for the entire process of Engineering, Preparation, Removal and Disposal, implying a significant increase in scope and responsibility. HMC is no longer a subcontractor, but takes on the role of *main contractor*, coordinating other subcontractors to perform the necessary project operations. As the platforms are already shut down for several years, HMC will need to carefully examine the platform’s structure and integrity to determine the best method for removal. The EPRD process is split up into two separate campaigns, e.g. the removal of the platform’s topsides and jacket structure. For the topsides campaign, the platform has to be cleaned and “made safe” so contractors can work on “hooking down” all the different modules. After that, each module will be lifted and lowered onto a barge for transportation. In the mean time, the jacket structure will be carefully examined by ROV’s. During the jacket campaign, marine growth will have to be removed from the jacket’s legs in order to allow cutting equipment to be installed. Both topsides and jacket are transported to a disposal yard for dismantling and recycling (see appendix G). The large scope of an EPRD project together give a clear indication of the risks and challenges HMC faces in the coming years (see figure 10).



3 Chapter

"Only by means of a full understanding of the tasks may we find means relevant to their solution. It is more important for the result to put correct questions than to give correct answers to wrong questions."
Christian Norberg-Schultz

3.1 Research motivation

3.2 Research questions

3.3 Research paradigm: Design Science

3.4 Research Method

3. Research Design



The previous chapters introduced the current and future challenge of HMC to cope with uncertainties and risks in complex EPRD projects. This chapter describes the research design for this thesis. The research design consists of selecting an appropriate scientific framework, followed by defining the general research approach. The research questions are stated and research methods and techniques are selected. Together, this will form the methodology for the research described in this report.

3.1 Research motivation

Chapter one argued the current (and future) challenge HMC is facing with the management of large decommissioning projects. This challenge can be summarized as the effective management of uncertainty and risks in complex EPRD projects. Risks in current EPRD projects rise from increased dynamics and complexity, together with the new role HMC takes on as a main contractor. And as the entire industry is still relatively inexperienced when it comes to the removal of the larger platforms in the North Sea, HMC finds itself at the lower end of the learning curve.

One way to deal with the complexity and uncertainty associated with the management of large and complex projects is to implement an effective risk management process. Such a process allows management to identify uncertainties and risks in a proactive manner, using this knowledge to support effective decision-making throughout the entire project lifecycle. The current HMC risk management process has only recently been implemented (2006), and there is little known of its contribution to the effective management of project risks. This research focuses on the analysis of PRM at HMC and the improvement thereof. Consequently, there are two aims to this thesis:

To bring the knowledge of project risk management and application thereof to an adequate level for managing risks in complex EPRD projects (*The aim of the research*).

doing so by,

To develop an approach for the improvement of current project risk management to best practice standards (*The aim in the research*).

3.2 Research questions

The key research question is the objective and main problem defined in a question (Verschuren and Doorewaard, 1999). Based on the research aim and problem description set out in chapter one, the key research question of this thesis is defined as:

How can the current HMC project risk management process be improved to best practice standards to cope with project risks & uncertainties in complex EPRD projects?

The thesis focuses on the *process* of *project risk management*. The current PRM practice of HMC is explored in the context of EPRD projects. The need, focus and problems of managing uncertainty and risk in this type of projects are discussed. Next, the risk management process implemented at HMC is analyzed and evaluated to identify gaps between current, desired and best practice PRM. This will create a better insight into the effectiveness of the HMC's PRM process, as well as contributing to the development of an approach for its improvement to best practice standards. To answer the main research question, the following sub questions need to be answered:

Explorative-oriented research

I. On exploring the relevance of risk management in EPRD projects – chapter 4

- 1.1 Which uncertainties and risks affect the management of EPRD projects?
- 1.2 What is the desired level of risk management implementation for EPRD projects?
- 1.3 Why is explicit risk management important in EPRD projects?

II. On exploring the theory and practice of project risk management – chapter 5

- 2.1 What does the process of project risk management look like?
- 2.2 What is “best practice” project risk management?

III. On exploring the HMC process for risk management – chapter 6

- 3.1 What does the current HMC process for project risk management look like?
- 3.2 How is the process for project risk management applied in current EPRD projects?

Development-oriented research

IV. On developing an approach for improving HMC risk management – chapter 7, 8 & 9

- 4.1 How can the HMC risk management process be improved to cope with the complexity and risks in current and future EPRD projects?
- 4.2 Which recommendations can be made to improve the application and effectiveness of HMC risk management process in EPRD projects?

The research performed in this thesis is divided into three parts; e.g. *Orientation, Exploration and Development*. The orientation phase deals with the specification of the research problem, context and the objective of the thesis. The explorative phase can be divided into three subparts:

1. The risks and complexities associated with the management of large EPRD projects from the perspective of HMC. Creating a better understanding of the need and difficulty of managing risk in EPRD projects.
2. A literature review on the subject of project risk management aims at creating an overview of the methodological principles of managing project risk. The process of risk management is explored, and “best practices” are identified. These results will form the basis for the analysis of HMC risk management in part three of the explorative phase.
3. Comparing the current HMC risk management process with best practices from literature, making it possible to identify considerations for improvement.

The results of the explorative research phase form the input for developing an approach for the improvement of current risk management practice at HMC, the third phase of the thesis. Research changes from an explorative to a development-oriented perspective. Finally, recommendations are developed for enhancing HMC's PRM process to better suit the risk profile of complex EPRD projects.

3.3 Research paradigm: Design Science

In the next section, the ontological and epistemological choices that underlie the research design are discussed. Together, these make up the scientific framework for the research described in this thesis. *Ontology* concerns assumptions about the *nature of reality*, e.g. the types of entities assumed to exist (philosophy of being). *Epistemology* provides the assumptions for understanding the *nature of knowledge about reality*, which is also referred to as the philosophy of knowledge, regarding the possibilities of, and limitations on our knowledge of the world (Mingers and Brocklesby, 1997). Both ontology and epistemology are different philosophical dimensions in which separate research paradigms can be distinguished. A *paradigm* is a very general set of philosophical assumptions, giving important implications on how the world is perceived and how we should approach the world's complexity to create understanding (Mingers and Brocklesby, 1997). In this sense, a paradigm can be seen as a system of scientific habits that is used by a group of scientists to solve scientific questions (Masterman, 1970).

3.3.1 Ontology: Hermeneutic paradigm

Within the ontological dimension, two opposite paradigms are considered: The *positivistic* and the *hermeneutic*. The positivistic perspective prescribes that observation and reason are the means to understand the complexity of human behavior, assuming the reality as being *objectively given*. This perspective is primarily used in the field of natural sciences, where research is content-directed and the world is perceived to exist independent of any observer (Olsson, 2006).

In contrary, the hermeneutic perspective is more suitable for research in the organizational sciences, as it considers the world as a *social construct*. It therefore recognizes the *subjectivity* of reality, as reality is interpreted by humans according to their own beliefs and value systems (Trochim, 2006). Within the hermeneutic paradigm, Dake (1991) introduced the term *personal worldview* as the individual attitude a person has towards the world and its social organization. Regarding risk management, it is assumed that one's personal worldview affects the perception of and attitude towards risk. For this reason, research on the subject of risk management requires a **hermeneutic** ontological view, recognizing the different attitudes of individuals towards risk and their interactions within a social context.

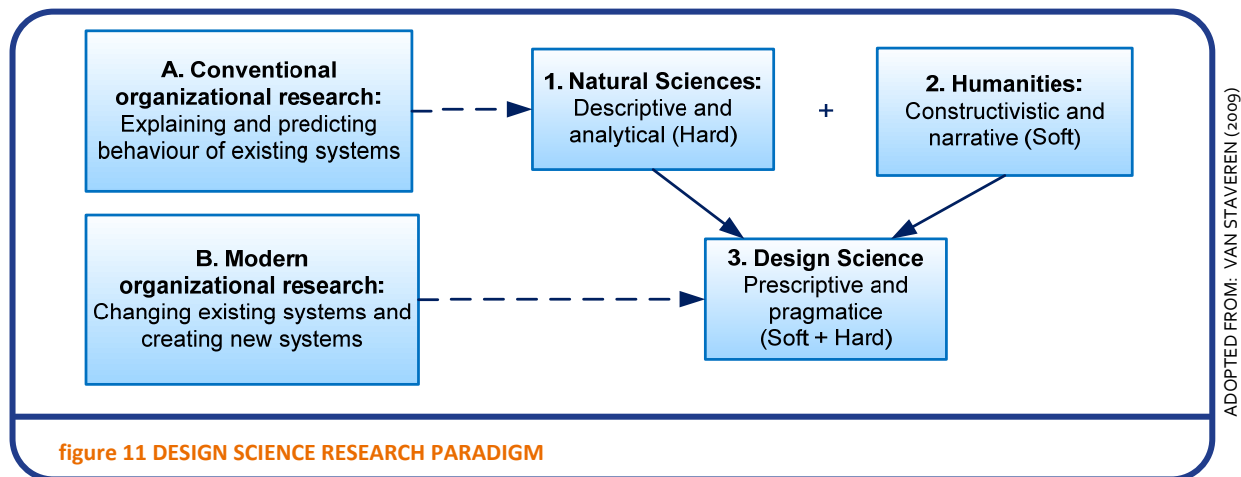
3.3.2 Epistemology: Design Science - a system's approach to project management

The epistemological dimension indicates the way in which knowledge on the subject of study is collected and analyzed. According to Mingers and Brocklesby (1997), a distinction can be made between two main paradigms, each of which has been referred to by various names: *empirical-analytical* (positivist, objectivist, functionalist, hard) and *interpretive* (anti-positivist, subjectivist, constructivist, soft) paradigm.

Within the *empirical-analytical approach*, research focuses on identifying causal relationships by simply describing the phenomena that we experience. This perspective gives importance to research methods focusing on quantitative analysis, surveys and experiments, and is generally applied in natural sciences (Romme, 2003). In contrast, the *interpretive approach*, assumes that knowledge lies within the individual experiences of reality. Research within this perspective is therefore mostly applied in the field of humanities, focusing on the complexity of human decision-making as the situation emerges. This perspective gives importance to qualitative analysis, personal interviews, participant observations and case studies (Dash, 2005).

However, as these conventional paradigms mainly focus on *explaining* and *predicting* the behavior of existing systems, a third scientific field of research is considered: **Design science**. Design science is widely applied in engineering, architecture and medicine and concentrates on *changing* existing systems, either by improving or by creating entirely new systems. In a sense, design science combines both interpretive (soft) and analytical (hard) perspectives in a *systems approach* for the creation of knowledge (Van Aken, 2004), which is shown in figure 11.

The research described in this thesis is performed in the field of Project Management, aiming to improve the HMC PRM process for managing complex EPRD projects. Initially, project management has been considered to have a strong link with the hard paradigm. But findings from Pollack (2005) suggest a growing acceptance of the soft paradigm in this field of research. Pollack indicates that the conventional project management paradigm is changing, as complex and uncertain situations require a softer approach that addresses the ability of project parties to effectively work together. In fact, both perspectives are needed and their 'mix' depends on the project's complexity and uniqueness (Murray-Webster & Simon, 2007). For improving PRM practice, a more pragmatic and solution-oriented approach is desired that acknowledges both the hard and soft dimensions of project management. Design science fits this prescription as reality is explored through constructive intervention, integrating both "systematic" and "people" necessities for success in a complex and dynamic environment.



3.4 Research method

A crucial aspect of every thesis is how the researcher should discover, describe, explain and intervene with the problem under investigation. Therefore, the choice for an appropriate research strategy (e.g. methodology) is discussed. Such a strategy consists of a structured set of guidelines or activities, forming a general plan for the proposed research (Mingers and Brocklesby, 1997).

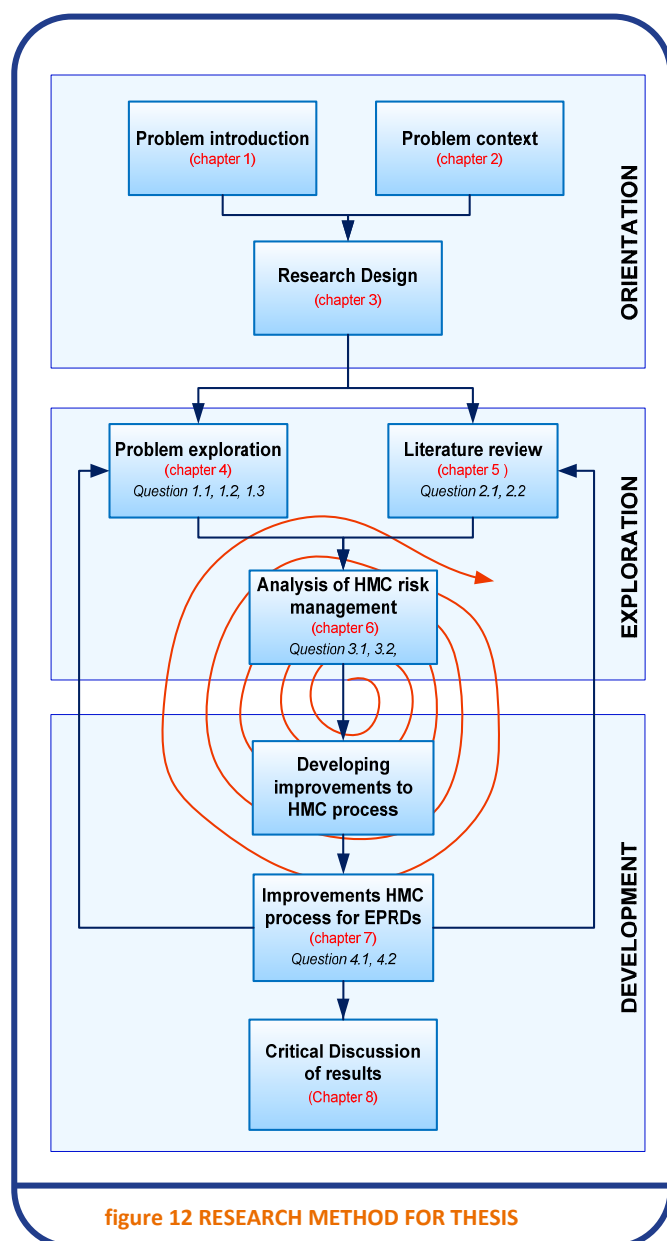
The choice of the research strategy depends on the type of problem that is studied and the status of theory development within the research field (Sol, 1982). The analysis of HMC risk management practices and its improvement to best practice standards can be classified as an ill-structured problem, because there is little consensus on the source and severity of the problem and there exist no indisputably right solution to it (Enserink, 2004). Within HMC, there are various people involved in PRM who have opposing perspectives on the process for managing risk and the desire for its improvement. The research problem of this thesis is therefore not directly recognized and supported by everyone within the organization. Some might embrace the improvement of risk management for large EPRD projects, while others do not see the need to do so in the first place. Furthermore, there exists a variety of alternatives for analyzing and enhancing the process. Currently, there are many different theories and guidelines on how to implement a PRM process, implying the absence of a single "best solution" (Arrow, 2008).

In addition to the ill-structured nature of the research problem, there is little scientific literature on how organizations might improve their project risk management practice to fulfill their specific needs. Currently, many organizations fail to apply risk management across projects (Mullaly, 2006). And although many organizations recognize that risk management matters, they are not implementing it effectively (Hillson and Simon, 2007). Accordingly, risk management needs to be tailored to the specific needs of the organization to make it effective in practice. This thesis project therefore focuses on generating solution-oriented knowledge, analyzing the specific situation of HMC and developing a tailored approach for improving HMC risk management in EPRD projects. To do so, the intervention cycle of Verschuren and Doorewaard (2005) is selected, that contains five successive steps: (1) raising awareness about the problem, (2) diagnosing the problem, (3) designing a solution, (4) intervening the problem with the designed solution, and (5) evaluating the designed solution.

The intervention cycle can be seen as a *multi-methodology*, combining and partitioning parts from different paradigms (Mingers and Brocklesby). The first part of the cycle consists of exploration-oriented research, divided in an exploratory part and a synthesizing part. Then the research shifts to more development-oriented research, consisting of synthesis-evaluation iterations to get to the final solution.

In the explorative part of the thesis study, a soft perspective is chosen to assess the needs for improving risk management in complex EPRD projects. Information is gathered through qualitative methods, such as contextual data, shared meanings, interviews and a case study. Without understanding the individual perceptions of the reality of managing risk, it would be very difficult to answer the proposed research question.

Next, research shifts towards the hard paradigm in the development phase. Conclusions from a literature review on the theory of managing risk are used for the identification of possible improvements to HMC's current PRM process. The ill-structured nature of the research problem recognizes the need for an iterative or evolutionary design cycle (Boehm, 1988). Therefore the spiral model is chosen as the suited approach for the second phase of the thesis project (see figure 12).



In this chapter, the research questions, approach and methods have been defined. These form the start of the thesis. In the next chapter, the drivers of risk in EPRD projects are explored through case study research, focusing on the context, desire and importance of explicit risk management in the light of the current EPRD projects HMC has taken on.

Chapter 4

"In practice, decision-making is always in the face of uncertainty. waiting for an impossible absolute truth means never doing anything."
D. Bradbury

"If we don't actively attack the risks, they will actively attack you"
Barry Boehm

4.1 Method Used – Case Study

4.2 Why are all projects risky?

4.3 Different context of removal projects

4.4 Project complexity: The driver of risk in EPRD projects

4.5 The benefits and importance of explicit PRM

4.6 Summary and conclusions

4. Risk in EPRD projects



Previous chapters of this thesis report have argued HMC's challenge of effectively managing risks and uncertainty in complex EPRD projects. However for the analysis and improvement of the current HMC PRM process, more insight is required into the main drivers of risk in these projects. What makes removal projects different from conventional installations, and which characteristics cause these projects to be perceived as complex and highly risky?

This chapter analyzes the context, desire and importance of an explicit risk management process to HMC in the light of the perceived risks that affect current and future EPRD projects. The aim is to create a better understanding of the factors that contribute to project complexity and uncertainty, and the specific requirements they pose on the project's management system. The following research questions will be discussed and answered:

- 1.1 Which uncertainties and risks affect the management of EPRD projects?
- 1.2 What is the required level of risk management implementation for EPRD projects?
- 1.3 Why is explicit risk management important in EPRD projects?

Arguments in this chapter are based on an extensive case study of the NWH and Ekofisk EPRD projects. Detailed information on the cases, the case study's lay-out and its findings can be found in appendix I. The case study focused on the identification of specific sources of risk that influence performance in current EPRD projects, illustrating the relevance of explicit risk management in relation to project success. The analysis addresses project risks at a managerial level, viewed from the perspective of HMC in their new role as main contractor.

4.1 Method used for problem analysis – Multi-case study research

Case study research will be used to explore and identify sources of risk in current EPRD projects, because it fits the interpretative research paradigm argued in chapter 3. The intention of case study research is to analyze the problem in its natural setting, using qualitative methods and observations to create specific knowledge. The risks in current EPRD projects are highly context-related, hence case study research is considered to be a valid approach as it provides a multi-sided view of the problem in its real-life context (Stake, 2000).

The main critique on using case study research is that it offers little basis for good scientific generalization as one cannot build theories on a single case (Yin, 2003). Therefore this thesis will consider two cases for the collection of information; e.g. the NWH and Ekofisk EPRD project. This creates a more thorough understanding of the specific elements that drive the heightened risk

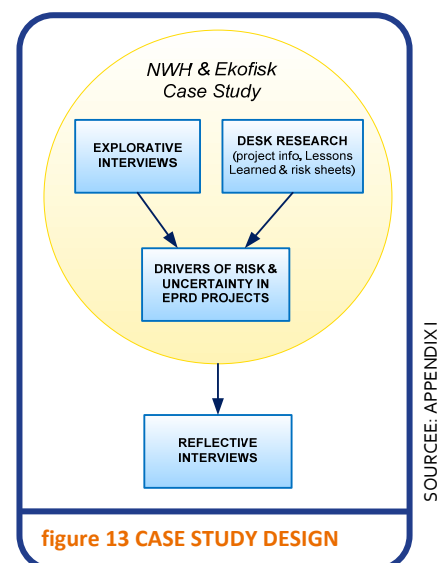
profile in these projects. Common positivistic critics of case studies are that they “lack rigor”, are “prone to bias”, and “they take too long and result in massive, unreadable documents” (Yin, 2003). A way to overcome these critics is to carefully plan and design a case study, addressing issues of rigor and bias. A case study protocol is therefore used for the development and structuring of the case study (see appendix I), providing essential guidance for the collection and analysis of information. This protocol assists in making adequate choices on the objectives, methods, instruments and means for collecting and structuring case study information, which is described into detail in appendix I.1.

Risk is a multidisciplinary and contextual concept, which makes the identification of common drivers behind the heightened risk profile of EPRD projects very challenging. Risks change over time as the project proceeds, and how a risk is perceived depends on the specific experience, attitude and responsibility of the person questioned. To rule out project specific bias as much as possible, a multi-case study is chosen as the desired approach. Both the NWH and Ekofisk EPRD project provide valuable input for the analysis. However, it should be noted that each has its own specific characteristics that cause risks. Many risks and uncertainties that were present in the NWH project may not be apparent in the Ekofisk project, as lessons learned have been implemented to minimize risk. In order to get an objective view, the researcher needs to adopt a pragmatic approach to filter the information acquired, addressing the similarities and differences of the two cases under investigation and the subjectivity of the person questioned. The case study will focus on project risks at a managerial level, from the perspective of HMC as the main contractor. And because all of HMC’s projects are essentially risky, research will explicitly address risks that are new to HMC in EPRD projects compared to previous installation and removal projects.

The strength of a case study research is the opportunity to use multiple data sources, therefore creating a more valid and rich description of the case. Both desk research and semi-structured interviews with project personnel will be used for the collection of information in order to create a holistic and meaningful perspective. The most important results of the case study analysis are described into detail in appendix I. Next to the interviews, the project’s risk register proved to be a helpful starting point to determine the focus of the case study. Furthermore, the risk register and other risk documents assisted with the interpretation of interview results (figure 13).

In total, 18 explorative interviews have been held with the management of the NWH and Ekofisk project to gain additional insight on findings from analyzing project documents. Appendix N gives an overview of the interviews that underpin the case study analysis and thereby functions as an important point of reference for the results described in this chapter. After summarizing the initial results, reflective interviews with key project personnel have been used to validate case study findings (see appendix N). Information is structured using the Risk Breakdown Structure (RBS) of Hillson and Simon (2007), which can be found in appendix I.1.4. The RBS distinguishes between Technical, Managerial, Commercial and External risks according to the element that forms the main cause of the risk.

Within this chapter, findings from the explorative case study (see appendix I.2.3) are contrasted with literature on the subject of Project Management and Project Complexity. I have taken great care to support the case study findings and claims described in this chapter by the thorough research of others, to make sure it is not just my own interpretation of the case’ information. In essence, PM theory (Hard perspective) and qualitative knowledge derived from interviews with project managers (Soft perspective) are contrasted to create a solid and rich picture of the specific elements that cause the heightened risk profile of current EPRD projects from the perspective of HMC.



4.2 Why are all projects risky?

One constantly plans, undertakes and executes projects. Accordingly, we are all quite familiar with the word “*project*” as it is often used in our daily vocabulary. However projects come in a large variety of ways, forms and sizes. In our social lives, a project might imply the redecoration of the yard, or changing the color of the living room. While in business the same word is used for the construction of a nuclear power plant or the implementation of a new computer system. So it seems that our common understanding of the word project is in fact somewhat deceiving, as it proves to be very challenging to provide a solid and sound definition of what a project actually is. Turner (1999) gives a set of common definitions for the word project:

- “an endeavor in which human, financial and material resources are organized in a novel way to undertake a **unique** scope of work, of given specification, within **constraints of cost and time**, so as to achieve beneficial change defined by quantitative and qualitative objectives”
- “a human endeavor which creates change, is **limited in time** and scope, has mixed goals and objectives, involves a variety of resources and is **unique**.”
- “a complex effort to achieve a specific objective within a schedule and budget target, which typically cuts across organizational lines, is **unique** and usually **not repetitive** within organizations”
- “a **unique** endeavor by people to do something that has not been done that way before”
- “a **temporary** endeavor undertaken to create a **unique** product, service or result”

From these definitions some common characteristic may be derived that apply to all projects. Two of these are of specific relevance to the topic of risk in projects, and will be discussed briefly.

First, all projects are considered to be **unique**. This distinguishes projects from more routine undertakings like processes or programs. The uniqueness of a project causes *uncertainty* as there is only little possibility to make use of past experience. It is therefore very hard to know in advance if the project’s plans and estimates will deliver the intended result. In addition, it is more difficult to monitor the project’s performance because there are no clear means for comparison (Bruijn, 1996).

Secondly, projects are temporarily or **transient**. Therefore each project has a sense of urgency to achieve the associated benefit as soon as possible and at a minimum cost. Projects are therefore *goal-oriented*, and in most cases accompanied with a predefined budget and schedule target to which the specified objective (and expected benefit) should be achieved (Turner, 1999).

As a result, all projects are essentially risky, because risk arises from interaction between objectives and uncertainty (Hillson and Simon, 2007). Risk is what makes projects special, as there is a constant tension between predefined plans and the uncertainty about the future. It is therefore important to recognize the fact that all projects and their management involve decision making under uncertainty, and that addressing project risks is central to the success of every project. Consequently, risk management is widely recognized as an essential part of project management (Crawford et al., 2006; Kutch and Hall, 2009; Tuner, 1999)

4.3 Different context of removal projects compared to installations

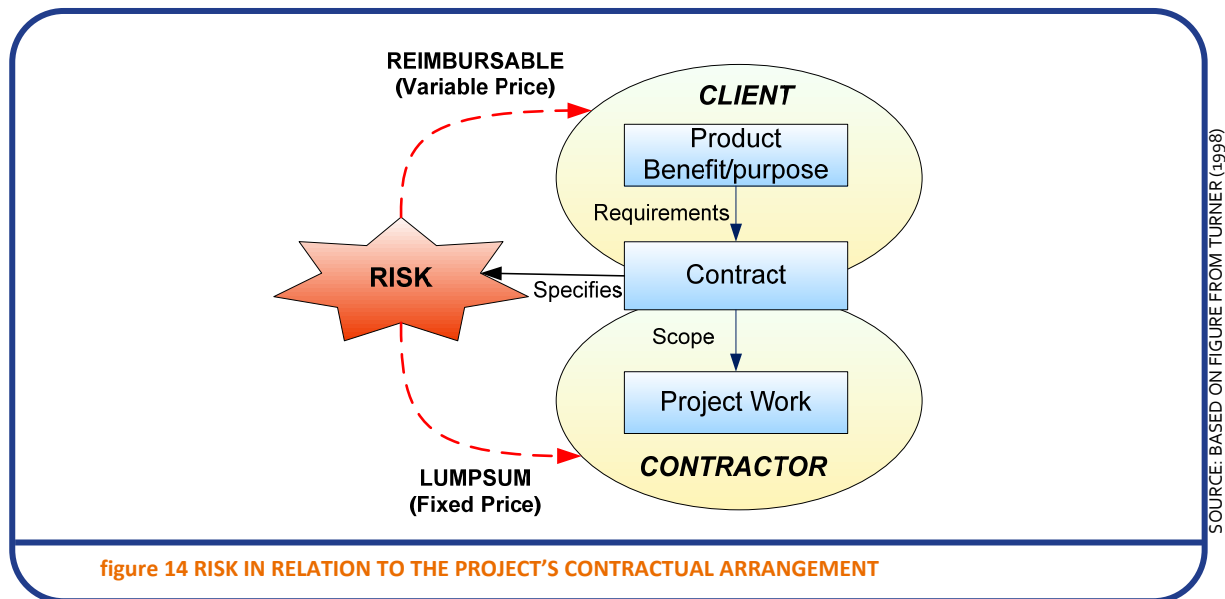
There is no doubt that risk forms an integral part of HMC’s core business activities, as HMC takes part in the world’s most complex and technically challenging projects. While the worldwide energy demand continued to grow rapidly during the past 50 years, oil companies constantly pushed the limits in their relentless quest for the offshore black gold. But in the end, it was up to marine contractors to face the challenges and risks associated with the installation of giant platforms under continuously changing conditions. The excellent reputation of HMC as a marine heavy lifter indicates that over time the company has proved to manage its risks effectively on a continuous basis.

However, the perceived risks vary greatly for every project that HMC takes on. Project specific designs, locations, environmental conditions and stakeholders are factors that introduce significant risk into each and every project. Installing a platform in the shallow waters of the GOM has a totally

different risk profile than executing a giant EPIC project in Africa. However there is one factor that drives risk in all offshore installations: time. Oil companies have made a colossal investment for the installation of an offshore platform, and need to get it up and running as soon as possible to be able to repay their debts. Offshore installations are therefore always time-driven and focused on achieving the magical *“first drop of oil”* deadline as soon as possible. For marine contractors, this implies a focus on safety, technical performance (quality) and above all a timely delivery of the project. Oil companies are willing to pay a lot of money if they can be guaranteed that their platform is installed safely, without any damages and above all on time. This has led to the development of the SSCVs in the late 1970s by HMC. The large capacity of the SSCV cranes and increased stability meant that HMC was able to perform offshore installations all year round and in a fraction of the time it used to take. Furthermore, larger chunks could be lifted so less dangerous offshore procedures were necessary because most of the construction work could be completed on shore. The use of the SSCV concept drastically changed the risk profile of offshore installations and opened up numerous new possibilities. But as the risks changed, so did the party who was held responsible for the management of risks and their consequences, as at the same time the type of contract between client and contractor changed from reimbursable to Lump Sum (Interview 8, 12 and 26, see appendix N).

While a contract cannot make risks “go away”, it does give a clear specification of who is responsible for managing each individual risk and who eventually has to pay for the consequences of the risk if it occurs. Contracts set the “risk barriers” of a project, and indicate to which party risks are allocated. Traditionally, offshore installations have been contracted on a reimbursable basis, where the owner of the platform bears the risk of the project. Contractors were paid on an agreed rate for every day’s work, so their income had been guaranteed no matter what the circumstances were. In the pioneering days, unforeseen changes were very likely and there was always a lot of uncertainty due to the great influence of the weather on offshore installation projects (Brkic and Romani, 2009). However as contractors became more experienced and less dependent on the weather because of the newly developed SSCVs, lump sum (or fixed price) contracts quickly became the standard. In a lump sum contract, the largest risk burden is transferred from the client to the contractor (see figure 14). This implies a higher profit margin for the contractor because the client also pays for the associated risks of the project. For the client, this guarantees a well defined cost and completion time for his project, significantly decreasing the chance of a cost overrun or schedule delay. Nevertheless, lump sum contracts require an excellent project definition that covers all the work needed for the project to be successful. This implies that with an installation project, all work that is not specified correctly in advance creates an opportunity for the contractor to gain extra revenues by a variation of the initial project scope set out in the contract.

According to Morris and Hough (1987) this has often lead to the situation where the contractor explicitly wishes to have initial targets exceeded, because their initial bid was low and the only chance of a good profit is by changing the contract conditions. Within the marine contracting industry, this phenomenon is not very rare as many projects still experience a lot of changes along the way. The client’s main interest with installations is a timely delivery, which gives contractors a strong bargaining position to push risks back to the client if they can assure the platform is installed on time. Accordingly, the “can-do mentality” of HMC and the focus on living up to their deadlines at all costs has significantly added to HMC’s success over the years (Interviews 11, 13, 18, see appendix N). Over the years, HMC has developed a risk taking attitude and a just-in-time way of working, which makes it possible to deliver complex projects on a tight schedule stemming from the company’s widespread experience, reputation and high quality standards. Empirical results from a study by Lyons and Skitmore (2004) confirm this notion, giving that 14 of the 17 questioned contracting organizations in the construction industry express a risk-taking attitude and management culture.

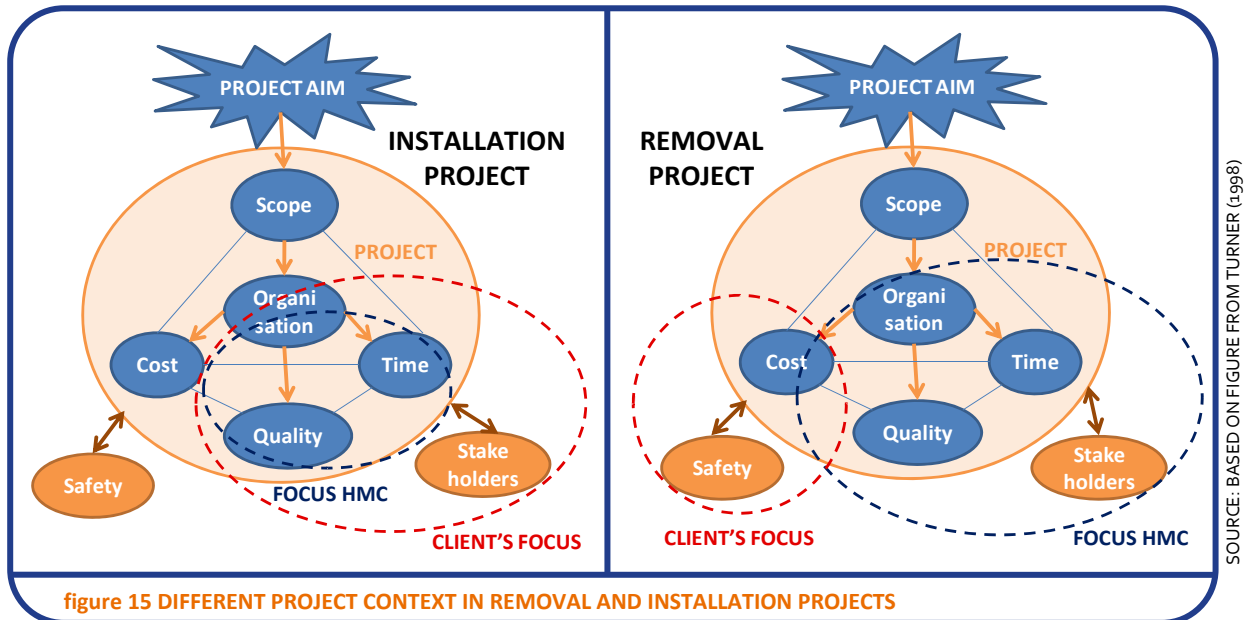


While a risk taking attitude and a just-in-time way of working may be essential for success in conventional installation projects, it may work against one in a large-scale removal project. It can be seen from table 8 in appendix I.2.3, that there exists a significant difference between an installation and a removal project that greatly affects the project's risk profile from the perspective of HMC. Yet, this difference might not be that obvious on first sight, as some argue that removing an offshore platform is simply a "*reversed installation*". From interviews with HMC management, it can be concluded that initially decommissioning projects were not perceived to be more challenging than installations (interview 2, 10 and 16, see appendix N). It had been argued that many of the drawings, tools, lifting points and other engineering aspects were already there, so for a removal you could "*simply*" reverse the old installation process. Besides, lifting scrap couldn't be more difficult than lifting brand new structures as there is a lower risk of costly damages to the structures when performing the offshore operations (Interview 16, see appendix N).

However, as there are many similarities between removals and installations from an operational perspective, they are considered to be totally distinct in terms of underlying project drivers. Removal projects are non-productive and therefore cost-driven instead of time-driven. As a consequence, the platform's owner (HMC's client) is more interested in getting a low price for the inevitable removal project instead of that it strictly adheres to a previously set deadline. Furthermore, environmental issues are more important in decommissioning projects as they are closely watched and affected by government agencies, environmentalists and the public (Interview 2, 8, 11, 18, see appendix N). The shift from time-driven to cost-driven orientation in removal projects as well as the focus on maintaining reputation by the client greatly affects the risk profile of EPRD projects from the perspective of HMC.

An important implication of the difference between installations and removals is that the focus of client and contractor becomes conflicting, meaning that both hold a different perspective on the project's main success factors (see figure 15). In T&I projects, both HMC and the client are focused on time & quality. The client has a direct interest in the risk of the project becoming delayed, and will therefore hold a more open and flexible attitude towards the interpretation of the contract, willing to share risks as the project proceeds. High margins are common, and HMC is among others paid for its good reputation, high standards and experience (interview 12 and 26, see appendix N). With removals however, there is less experience and the client will focus on keeping the price as low as possible, trying to get the most cost-efficient solution. As the platform's owner does not have a direct financial interest in the "*result*" of the project, he will be prone to shift the risks as much as

possible to the contractor, keeping a more closed attitude towards change. This makes it more difficult for HMC to get additional revenues for variations in the scope of work, because both parties may hold a different interpretation of the contract's contents. Consequently, the project risk-balance shifts, causing a heightened risk responsibility for the contractor in removal projects in contrast to installation projects. Dynamics are no longer in favour of HMC, but are more likely to rapidly turn the already small margins into losses.



As a result, it is more important for HMC to be aware of the risks that affect current removal projects. HMC can no longer afford a risk taking attitude in removal projects, but needs to be fully aware of the consequences and specific risks in advance. The industry's habit of using large lump sum contracts does not acknowledge the uncertainty and risks associated with current removal projects (interview 2 and 6, see appendix N), as it is much more difficult to commit to a total project cost and delivery schedule beforehand (Sjolberg, 2009). Furthermore, removals require a more cost-effective perspective from both the project's engineering and management teams. Because a good profit for the project no longer relies on getting a higher price for a timely project delivery, but on keeping the project's overall cost to a minimum. This implies the importance of balancing a practical and cost-efficient execution, next to a safe and timely delivery.

The change in risk balance between installations and removals clearly indicates the importance of risk and the management thereof to HMC in current EPRD projects. However, the heightened risk profile of removal projects does not only stem a change in the project's context. Risks also stems from an increase in scope and responsibility of EPRD projects in comparison to the projects HMC has executed so far, which causes these projects to be increasingly complex.

4.4 Project complexity: The driver of risk in EPRD projects

As projects continue to increase in size and stretch over longer periods of time, it becomes increasingly difficult to ensure effective planning and budget setting. This development is further emphasized by the rapid increase in degree of complexity of today's projects in relation to their structure, technology, environment and organizational arrangements (Papke-Shield et al., 2009). We want projects to deliver greater benefits than before, and usually more quickly. In addition, projects tend to involve more participants in the decision-process, adding the issues of conflicting goals, expectations and interests. Success therefore no longer relies solely on solving the technical challenges, but is more and more dependent on addressing the social complexity of conflicting and competing stakeholders (Pollack, 2007).

Project complexity is generally associated with the size of the project, e.g. the number of tasks and processes. But larger projects are not necessarily more complex than smaller ones. Complexity in projects arises from the number of *subsystems* (differentiation and fragmentation of project elements) and the *interactions* between those subsystems (interdependency of project elements), which may stem from an increase in size (Perrow, 1999; Edwards, 2005; Baccarini, 1999 and Williams, 1999). *“The inherent complexity of large technological projects manifests itself as uncertainty to the project’s outcome, thereby affecting the predictability, controllability and measurability of the project”* (Veeneman, 2004). To effectively manage project risks in current EPRD projects, it is therefore crucial to understand the origins of project complexity and its relation to uncertainty and risk.

The topic of project complexity is discussed in the light of the EPRD projects that have been analyzed, for which the TOE framework of Bosch-Rekvelde (2009) has been used (see table 1). This framework has been developed to grasp project complexity from specific project elements, based on findings from literature and case studies of large engineering projects. Specific elements that add to the complexity of large projects are clustered into three categories, *technical complexity*, *organizational complexity* and *environmental complexity*. Each of these three categories addresses a different aspect of project complexity, and will be discussed in the light of the NWH and Ekofisk EPRD projects (see appendix I).

table 1 Framework for analyzing project complexity

TOE FRAMEWORK BY BOSCH-REKVELDT (2009)	
Technological complexity	project goals, scope, tasks, technical experience, technical risk
Organizational complexity	size of project, resources, project team, trust, organizational risk
Environmental complexity	Stakeholders, location, market conditions, environmental risk

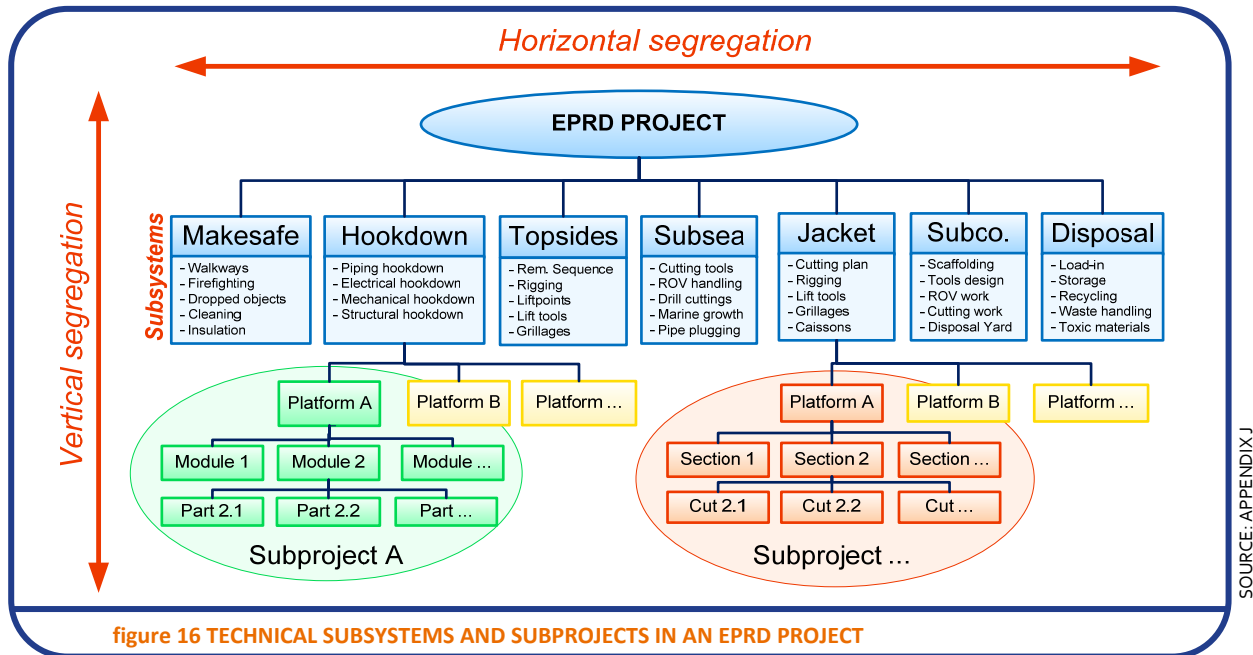
4.4.1 Technological complexity in EPRD projects

Technological complexity partially stems from the *number* of subsystems, goals and tasks that together make up the project as a whole (Perrow, 1999). However, complexity increases significantly as there are more *interactions* between those subsystems and the *understanding* of those interactions diminishes (through an overall lack or fragmentation of knowledge). Consequently, technological complexity is about the level of understanding of technical subsystems, affected by the innovative character of those subsystems and their interactions (Veeneman, 2004).

In the NWH and Ekofisk EPRD projects, the immense size of the platforms that need to be removed naturally divide the projects in manageable subparts. Past decommissioning projects performed by HMC could in most cases be lifted and transported in a single piece. However the NWH and Ekofisk jacket structures will first have to be cut into smaller pieces so they can be lifted and transported to shore. The same applies to the top structures that consist of several modules that each need to be cleaned, hooked down and lifted onto cargo barges for transport (see appendix G). In the NWH project for instance, the topsides are made up out of 22 separate modules and the jacket structure has to be cut up into 40 different pieces. Consequently, the cleaning, preparations, lifting and disposal of each of these parts adds to the technical complexity of the project as a whole.

Additionally, the large scope of HMC in current EPRD removals significantly increases the number of technical subsystems and subproject in the project, which can be seen from the large WBS of the project. In contrast to former removal projects, HMC takes on the responsibility for the entire decommissioning and removal supply chain. As a result, there are specialized teams for all hookdown operations, topsides and jacket removals, subsea operations, the coordination of subcontractors and disposal activities. Each of these technical subsystems falls under the management of HMC, and will require intensive coordination in order for the project as a whole to be successful.

Because of the large scope and size of the project, there exist multiple (sub)projects within an EPRD (see figure 16). For instance the removal of the topsides and jackets performed in two separate campaigns. Next, there are many parallel processes and operations performed offshore that have their own schedule and project team. Pipelines and risers need plugging, piles of drill cuttings have to be relocated and subsea structures require examination and the removal of marine growth. And as the Ekofisk EPRD project consists of the removal of 9 separate platforms, each of these platforms can be seen as a different project on its own, with a separate engineering team for both hookdown, topsides and jacket operations (see appendix J).



Accordingly, EPRD projects consist of many different subsystems that are developed by many different engineers. These subsystems will have to work together to make the system function as a whole. The large scope of EPRD projects causes horizontal segregation of tasks, while the increased size of the platforms causes vertical segregation by the physical parts that make up the project (see figure 16). Together, this creates multiple teams within the project's organization that each run their own specialized subproject within the overall EPRD project. The growth in number of subsystems in EPRD projects causes a fragmentation of technology, adding to the technological complexity and uncertainty. However technological complexity does not only stem from the number of subsystems, rather it rises from interfaces between those subsystems (Gigh, 1999).

"Complexity rises as interactions proliferate and understanding of those interactions diminishes" (Veeneman, 2004). Large projects are often divided into manageable subparts, it becomes more difficult to coordinate and align the different technological aspects to effectively work together as a coherent whole. The connectedness and interdependence of separate parts of the project further emphasize the importance of those interactions, as problems and risks in one part of the project might easily spread to other parts. From interviews, it became apparent that installation projects are for the greater part made up out off sequential processes (interview 2, 7, 8 and 10, see appendix N). First the jacket is installed, and then each subsequent module is lifted and lowered in place. HMC moves on to the next installation and another contractor starts with the labor-intensive process of connecting all the pipelines and electrical wires until the platform is ready for operation.

However with EPRD projects, a lot of processes are performed in parallel to make efficient use the SSCV. HMC has adopted a “one vessel approach” that significantly increases the complexity of the project as there are more interactions between processes and subsystems (see figure 17). During the NWH topsides campaign, hook down and removal operations are performed at the same time. And as hooking down a module consists of numerous small activities, it poses a significant risk to delaying the entire offshore campaign. In addition, subsea activities run alongside the topsides removal. ROV’s are deployed for jacket inspections, marine growth removal and pipeline plugging. And when a topsides module is lifted, all subsea activities must come to an immediate standstill.



SOURCE: DE BOER (2009)

Apart from the interactions and tight coupling of separate processes offshore, there are many technical interactions between the project’s subsystems that fall under the responsibility of HMC. In an EPRD project, HMC is not only responsible for managing its own interfaces but also has to take care of the various interactions between subcontractors along the entire project chain. The team that is responsible for engineering the cutting tools interacts with the jacket team that makes up the cutting plan. Contractors that develop new cutting tools will need to carefully collaborate with ROV operators to test and assess offshore workability issues. HMC engineering will need to discuss their plans in advance with offshore personnel to solve the practical issues of newly developed removal concepts. Furthermore, the entire logistics and supply chain has to be carefully monitored and planned to make efficient use of all project resources and ensure a smooth sequence of operations. The increased number of interactions, together with the importance of those interactions due to tight coupling and a constant time pressure further increase technological complexity in EPRD projects.



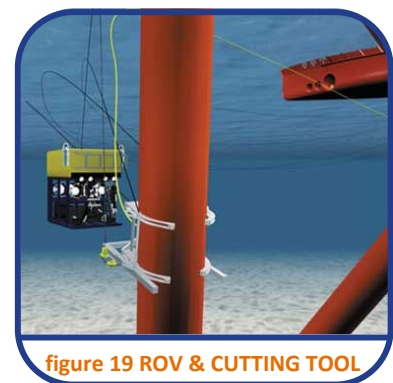
SOURCE: DE BOER (2009)

It can be concluded that technological complexity rises as there are more subsystems and interactions, however Veeneman (2004) stresses that in fact technological complexity is all about knowledge. Because when a project’s size grows and interactions rise, understanding and overseeing the project as a whole becomes more difficult and thus more complex. This effect is strengthened if the project and its subparts include more innovations. Technological innovations and newly constructed interactions influence the creation and distribution of complexity throughout the system. And as the entire marine contracting industry is still relatively inexperienced when it comes to the removal of the larger fixed platforms of the Northern North Sea (see chapter 2), there are many aspects of an EPRD project that are innovative. Hence, these newly developed systems, parts, concepts and interactions within a large EPRD project add to the perceived technological complexity of the project as a whole.

The most challenging and innovative aspect of the current EPRD projects is the removal of the large jacket structures. Initially, these steel structures were not designed and build to be removed. Most of the fixed jacket structures were constructed onshore, towed to their location and lowered into place using the air in the jacket’s legs to provide buoyancy (see figure 18). Consequently, the removal of

these structures requires the development of a whole new concept, as one must cut the structure in smaller pieces for lifting and transport. Currently, there is no knowledge on the best way to cut and lift such a large structure. On one hand, cutting the structure in smaller pieces makes it possible to use a lighter crane block that is able to maneuver more easily under water, requiring less maintenance and a smaller weather window to perform the operations. But on the other hand, one will have to make far more subsea cuts to cut the overall jacket structure in small pieces. And so far there is no experience with the cutting of steel structures of this size and at depths where one can no longer make use of divers. When it is decided to lift the structure in larger pieces, complex lifting tools are needed and a heavier crane block that is more sensitive to the waves and the weather. Besides, some of the structures are over 40 years old, which makes it hard to assess the structural integrity of the jacket when one tries to lift it in larger chunks. Consequently there need to be a consideration of all the elements that make up the removal concept for each and every jacket structure, carefully balancing operational, cost, time and safety issues to provide the best method for removal.

Additionally, new technologies will have to be developed for cutting, lifting and transporting the platforms, of which most are tested on the job (Interview 2 and 27, see appendix N). New cutting and lifting tools are developed, which add to the complexity of the entire removal job as there is a lot of uncertainty on their workings offshore (figure 19). Besides, there is little known on how effective ROV's can handle these newly developed tools at a greater water depth. Furthermore, there is an overall lack of experience on ROV handling, platform hook-down operations, drill cuttings removal, riser plugging and marine growth removal. The innovative systems in an EPRD project cause uncertainty to the project's outcome and may affect other parts of the project through interactions.



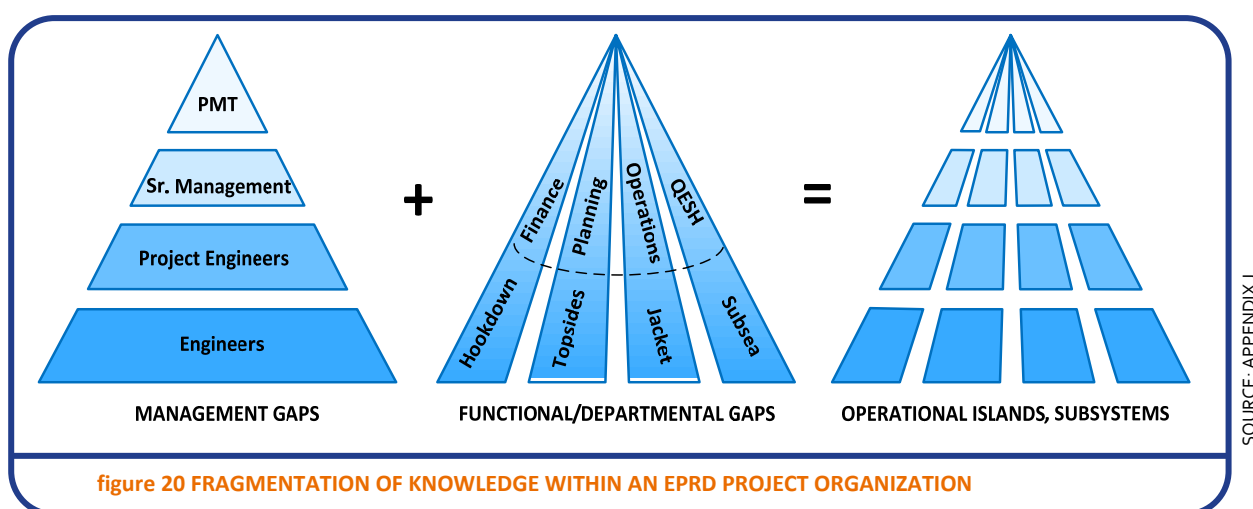
SOURCE: VAN VELZEN (2007)

For HMC as a marine heavy lifter, technological complexity rises partially from the fact that structures have to be lifted *on* a cargo barge instead of *from* a cargo barge (interview 25, see appendix N). With an installation job, HMC lifts a structure from a *moving* barge to a *fixed* jacket structure. When positioning the module on the platform, HMC can therefore carefully lower the structure to ensure a smooth and precise touchdown. However when one lifts a structure onto a cargo barge, the waves that cause the barge to move in all directions pose a higher risk of damaging the cranes, barge and structures. Therefore the weather has a greater effect on the entire operation (interview 3, see appendix N). In addition, HMC needs to develop new procedures, standards and guidelines for their operations because instead of lifting brand new structures worth millions of dollars, HMC is lifting scrap material ready for disposal. Expensive guides and bumpers to prevent the structure that is lifted from damaging other structures are not always necessary. And small distortions of the structure during a lift may be tolerated in some cases. Hence, one might question the need for expensive grillages (newly constructed steel frames that hold a module in place during transport) when you're transporting platform waste and corroded steel.

The combination of many technical subsystems, tightly coupled interactions and the use of innovative technology cause technological complexity in current EPRD projects. As a result, it becomes very difficult to keep control of the project as a whole. The size and scope of the project divide it into manageable subparts, which cause a fragmentation of technical knowhow. Understanding of the system and technology is constantly build up, and many new interactions between subsystems are introduced along the way. Innovation reduces the understanding of the project's technical subsystems, and interactions cause the spreading of this uncertainty from one part to other parts of the project. *"Hereby interactions and innovations strengthen each other in providing uncertainty and bringing complexity in large technological projects"* (Veeneman, 2004).

4.4.2 Organizational complexity in EPRD projects

As technical complexity entitles the limited understanding of the project's subsystems and their interactions, organizational complexity focuses on the issues arising from coordinating the people that do the actual work. Because as the scope of work within EPRD projects increases, so does the project's organization. And a bigger organization implies more barriers between specialized project teams, creating operational islands and a fragmentation of knowledge (see figure 20). From this perspective, complexity is concerned with the management of the owners of the different subsystems, concentrating on the interfaces between them. Organizational complexity rises from the social interfaces; the "locations" where interactions between project parties take place (Veeneman, 2004). Consequently, one should focus on the project's interfaces to create a better understanding of project complexity. A distinction is made between *internal* and *external* organizational complexity (Cleland and King, 1983).



Internal organizational complexity

Internal organizational complexity rises from interfaces between project members and teams, which are shown in the impressive organizational charts of the EPRD projects that have been examined (see appendix J). For the removal of the NWH platform, over 250.000 man-hours were spent during the engineering and planning phases of the project. The organizational layout of the Ekofisk EPRD project is even more impressive, with an internal organization alone of over 200 people. The Ekofisk organizational chart consists of 9 separate functional branches, each with up to five different hierarchical levels (see appendix J).

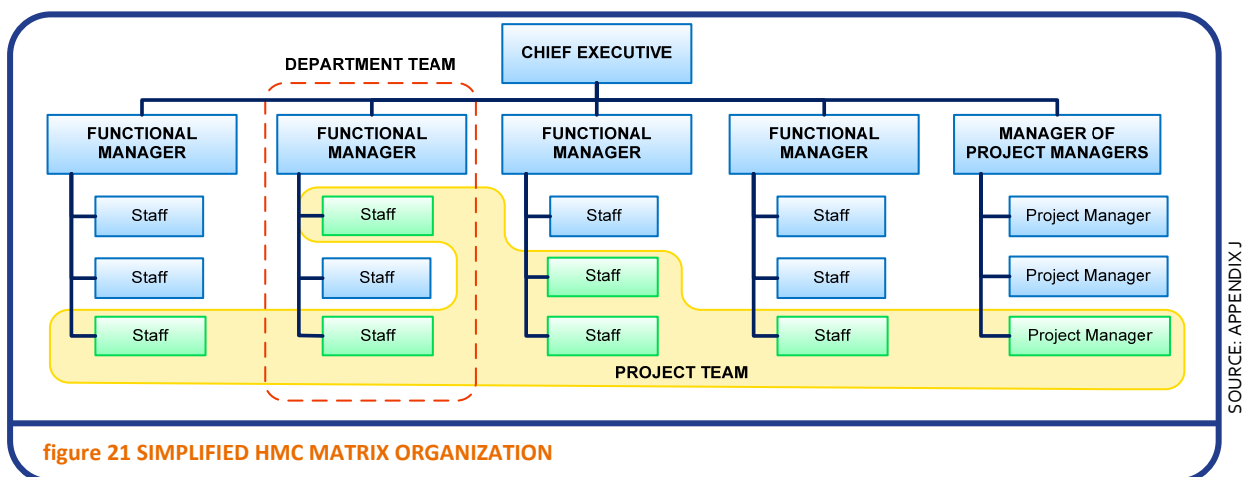
When the organizational lay-out of the project is more and more divided into separate teams with their own management, it becomes increasingly important to coordinate different project activities in order to manage the project on a higher level (Veeneman, 2004). Specialization of engineering disciplines (marine, structural, equipment) further adds to the organizational complexity, as it creates barriers between different project parties, reducing the ability to share (De Bruijn, 2002). These barriers are strengthened by diverging interest of the specialized subgroups within the project's organization, each holding a different perspective on the best way forward. Especially with innovative projects, intensive management of the project's interfaces is essential to resolve social conflicts and create common understanding.

Within current EPRD projects, this phenomenon can be seen between the project's engineering and operational staff. Engineers are responsible for the development of new concepts, often focusing on the theoretically most suited solution (interview 25 & 27, see appendix N). However the operational staff has the experience and knowledge to assess the effectiveness and workability of these concepts

offshore. For the project to succeed, these conflicting perspectives need to be resolved as soon as possible, to prevent problems and costly changes as the project moves along.

Control and coordination becomes more difficult if there are multiple layers of management within the organization. These layers diffuse understanding of the project as a whole, as the focus of top management is more distinct from the project's details. To ensure effective decision-making on a higher level, information needs to be summarized and simplified to create an overview of the total project. However, this often neglects the project's inherent complexity and the interactions between different systems. This makes it more difficult for a manager to steer the project as the rigid organizational structure hampers flexibility and reduces understanding, which forms an additional source of risk in complex projects.

The lack of managerial control and organizational complexity in EPRD projects is further strengthened by the *Matrix Organization* of HMC. A matrix organization attempts to maximize the strengths of both a functional and project-oriented type of organization. The entire company is divided into specialized departments, each having a functional manager. At HMC, there are different departments for the Project Management, QESH (Quality, Environment, Safety and Health), Finance, Logistics, Planning, Operations and Legal aspects of a project. The project's management team is made up out of different members from each department, under the control of a separate project manager. As a result, a person will be reporting to two bosses, e.g. the *Project Manager* and the *Functional Manager* (see figure 21)



However, the functional separation of the project team creates even more organizational islands, thereby making it more difficult to coordinate, monitor and control the project. The dynamics of complex and innovative projects require a flexible way of working, while constantly balancing issues of cost, time, scope and quality. However this is more difficult in a large organization that is divided into separate departments. Furthermore, there may be a differing perspective between functional managers and project managers on how to divide the company's manpower and resources. People may be working on different projects at the same time, adhering to both the objectives of the project and the department. Because EPRD projects are both innovative and technically complex, a matrix organization may therefore create more social conflicts due to an increased number of interfaces.

External organizational complexity

External organizational complexity rises from the interfaces between HMC's internal project organization and other stakeholders in the project. The more specialized subcontractors are needed for the project's operations, the more difficult it is to coordinate the project from an organizational perspective. Each additional party brings different goals, interest, desires and expectations to the table that cause conflicting situations and increases complexity.

During the topsides removal of the North West Hutton platform, over 500.000 man-hours were spent offshore, peaking at around 1.800 man-hours a day. Because HMC adopted a “one vessel approach”, over 15 different teams were present during the entire offshore removal campaign. And as there are many specialized operations involved in the removal of a large platform (subsea operations, lifting, rigging, scaffolding, sea fastening, rope-access, waste removal, hydrocarbon cleaning etc.), HMC took on the responsibility of coordinating and managing all these specialized teams as the project’s main contractor. As a result, the success of the project depends to a larger extend on the effective cooperation of all project parties, for which HMC is responsible in an EPRD project.

The offloading of parts of the project (and their risks) to external subcontractors creates additional risks and causes increased organizational complexity. Transferring risks to a party that does not have the knowledge, capacity or capability to manage it creates an illusion of control (Loosemore et al., 2006). If the subcontracted party is unable to perform against predefined conditions, the seemingly offloaded risks will simply fire back to the one party responsible for the project as a whole. In many cases, this creates an even bigger problem that is far more difficult to manage. Organizational complexity and risks in current EPRD projects therefore stem to a bigger extend from the many specialized activities that are outsourced to third parties. However these activities remain under the control of HMC as the project’s main contractor. If one of the subcontractors performs badly, it will eventually affect the project as a whole for which HMC bears the full responsibility. During the interviews with HMC management, the coordination of subcontractors was often indicated as a large source of risk in current EPRD projects (Interview 2, 8, 10, 11, 14, 16, see appendix N). HMC is not used to coordinate many external parties during the entire project lifecycle. In the NWH project, a number of “risky” parts of the project like for instance the development of specific cutting tools, adapting ROV’s to increase subsea workability and the disposal of all the structures onshore were offloaded to external parties. However if these contractors are not managed properly their individual problems eventually become collective issues for HMC. Chapman and Ward (1999) indicate that a prime contractor needs to explicitly consider how risks should be allocated to various external parties. Accordingly, HMC should make sure that their subcontractors are sufficiently capable and experienced to manage the project’s risk, and that there are adequate incentives in place to make sure they will do so effectively. This requires additional effort and adds to the complexity of EPRD projects from an organizational perspective.

Another important element that enhances complexity in removal projects is the difference in the platform’s legal case compared to installation projects (Interview 2 and 8, see appendix N). When HMC installs a platform, the legislation that affects the platform’s safety case falls under the responsibility of the contractor. HMC therefore has its own safety system that is specialized for offshore transport, lifting and installation operations. However with removals, the legal case of the platform falls under the supervision of the platform’s operator, until all physical structures have been removed completely. In other words, the specific operational rules and procedures of a particular platform apply to the entire removal operation. Furthermore, they remain under the platform’s operator control during the offshore campaign. This means that HMC will have to cope with an extensive “*permit to work system*” that is coordinated by the client. For each operation, a separate permit has to be issued in advance which may cause significant delays as HMC is used to a more flexible way of working. Furthermore, every operation is closely followed by the client’s safety inspectors, who may not always have the same perspective as HMC on the best way to perform the highly specialized operations. Consequently, this may cause conflicts and puts a lot of stress on all offshore operations in an EPRD project.

The organizational complexity of EPRD projects finds its origins in the barriers between specialized engineers, functional departments, different levels of management and the various external parties that all have diverging interests and perspectives. These barriers create operational islands and

reduce the ability to share information, making it more difficult for managers to steer, control and measure the project as a whole. The coordination of different subcontractors and their interfaces becomes more challenging, as knowledge becomes distributed across a large internal and external organization. Cooperation, collaboration and flexibility are therefore key elements in addressing the organizational complexity of EPRD projects.

4.4.3 Environmental Complexity in EPRD projects

The third category of complexity defined by the TOE framework of Bosch-Rekvelde is complexity that is caused by the environment, e.g. the project's locations, third parties and external market conditions. Any large technological project interacts with the outside world, and as these interactions are often hard to predict they can have a devastating effect on the performance of the project.

The first large difference between installation projects and removals are the different environmental conditions that cause a heightened HSE (Health, Safety and Environment) risk. Instead of working with brand new structures, HMC and its subcontractors will have to perform dangerous procedures on platforms may be over 40 years old. Some of these platforms have been left to the elements for over a decade, and poor maintenance has caused these platforms to become highly corroded and deteriorated. Working conditions change, as many walkways have perished and there are all kinds of loose objects that are laying around which form a major hazard to all operations (see figure 22). Furthermore, as the platform has been used to produce millions of barrels of oil, it is highly contaminated, containing flammable and toxic materials. Workers will have to remove asbestos, hydrocarbons, mercury and PCB's before they are able to safely lift the modules onto a cargo barge.



SOURCE: DE BOER (2009)

figure 22 REMOVAL HSE RISK



figure 23 THIRD PARTY INFLUENCE

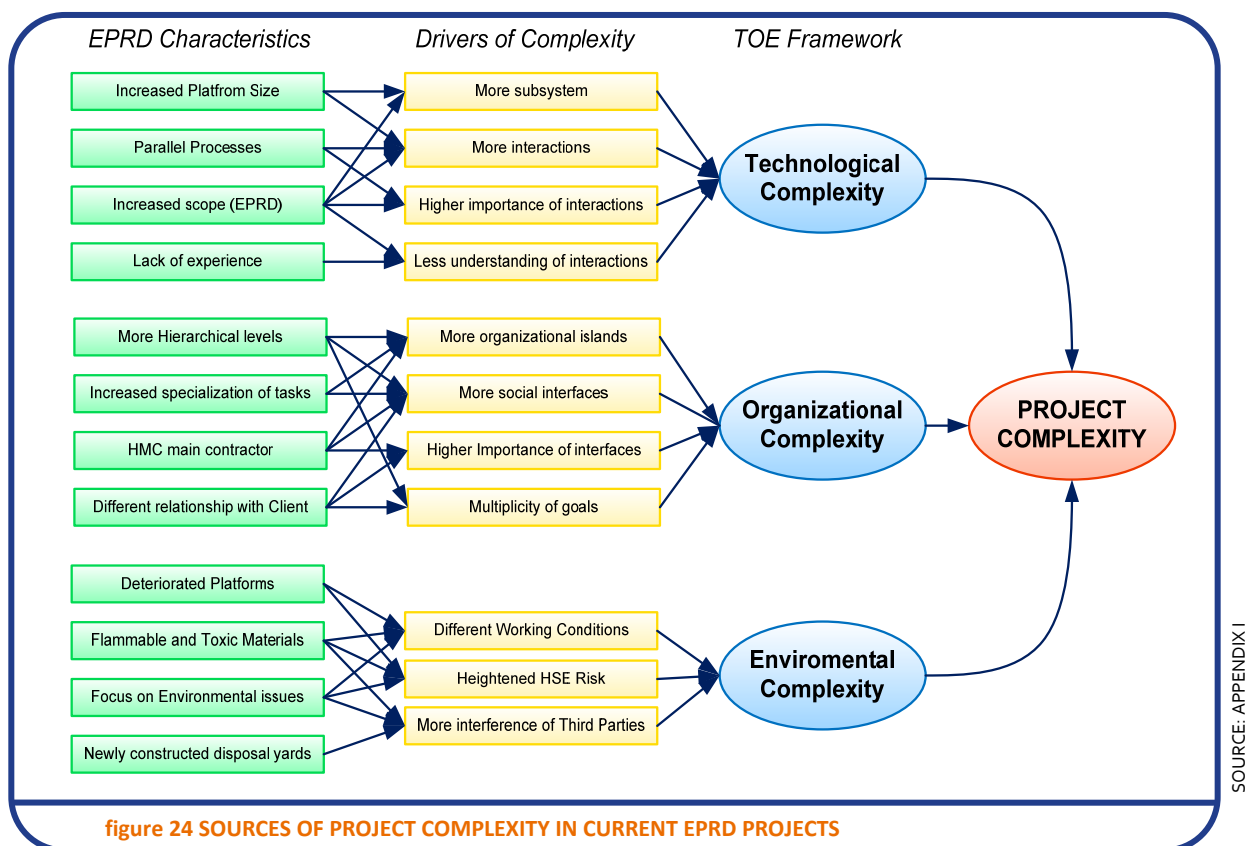
In addition, many dangerous operations (rope access cutting, marine growth removal, oil tank removal) are carried out in parallel, all in the proximity of platforms and pipelines that are in some cases still operational. The contaminated and deteriorated state of these platforms together with a tight coupling of activities causes environmental complexity. Each platform is completely different, and requires a lot of offshore surveys to make sure work can be carried out in a safe manner. An extensive "make safe" period is needed for all platform removals to fully clean the platform, install firefighting equipment, create safe walkways and remove loose objects.

The second difference between installation and removal projects is the greater affection and influence of third parties to the project's performance (interview 8, see appendix N). Since the Brent Spar case (see chapter 2), there has been a lot of public attention on the removal of large installations in the North Sea. The strict OSPAR regulations for offshore decommissioning require intensive collaboration with public parties, environmental activists and both international and local governments to gather support for the decommissioning program. For HMC, this implies dealing with many specialized regulations and permits that are needed for the removal, transport and disposal of hazardous materials. Newly build disposal yards may cause additional risk to the entire project, as local governments interfere with the required permits needed for construction and operation of these yards. For the Ekofisk EPRD project, a large disposal yard is constructed by AF Decom at Raunes in Vats (Norway) to dispose all

the Ekofisk topsides and jacket structures. HMC has planned to offload the structures on the 180m long quayside with the use of its SSCV, where it has to adhere to the environmental regulations of the Norwegian Fjords. Noise nuisance, pollution by contaminated rain water, transport of toxic materials etc. are all issues that may cause conflicts with the local government, eventually affecting the entire removal project as a whole. Consequently, the greater influence and affection of third parties in EPRD projects significantly adds to the project's complexity from an environmental perspective (see figure 23).

Summarizing, the increased scope and lack of experience in current EPRD projects causes project complexity. From the multi-case study performed in this thesis project, several differences have been identified between large EPRD projects and the more conventional offshore installation projects.

The increased number of technical subsystems, interactions and innovations causes these projects to be more complex from a technical perspective. The responsibility of HMC as a main contractor in coordinating all the different subcontractors and interfaces between specialized project teams and various subcontractors cause complexity from an organizational perspective. And the deteriorated and contaminated state of the platforms, together with a heightened influence of third parties causes EPRD projects to be more complex from an environmental perspective (see figure 24).



4.4.4 Uncertainty, Dynamics and Complexity: the drivers of risk in EPRD projects

The previous sections of this chapter have argued the different project drivers, focus and complexity of current and future EPRD projects. However what does this tell us about the risks in these projects? Are complex projects by definition more risky? And how does complexity relate to the subject of risk and uncertainty? As these important questions have still been left unanswered, the following section will aim at creating a more detailed understanding of the relationship between complexity, uncertainty and risk in complex projects from literature. Several research papers on the subject of project complexity have been reviewed to create a better understanding of project complexity and its relation to risk and uncertainty

Initially, Bacarrini (1996) proposed a twofold definition of “*project complexity*” in terms of a project’s *differentiation* (the number of varied elements) and *interdependency* (the degree of interrelatedness between these elements). The increase in size and scope of a project are considered to be important contributors to this notion of complexity, as they naturally increase the number of subsystems and interfaces within a project from both a technical and organizational perspective. However Williams (1999) indicates that this definition of complexity refers for a large part to the underlying structure of the project, and should therefore be referred to as “*structural complexity*”.

Williams (1999) indicates that there is a third element that adds to the concept of project complexity: *Uncertainty*. Other writers like Veeneman (2004), Jones (1995) and Turner (1998) share this idea that complexity depends to a large extent on the knowledge and understanding of the structural elements and relations that make up a project. Consequently, unique projects are more complex as they lack a common understanding of the project’s technology, goals and methods. Turner (1998) and Williams (1999) distinguish between “*uncertainty in methods*” (the newness of the technology to be used) and “*uncertainty in goals*” (the clarity on the project’s scope and objectives). With current EPRD projects, there exists an overall lack of knowledge due to the industry’s inexperience. Uncertainty therefore mainly stems from the “*project’s uniqueness*” that requires the development of new methodological concepts, technological innovations and novel organizational interfaces.

Consequently, the required innovations in EPRD projects strengthen the earlier defined structural complexity. Because more interactions and less understanding of those interactions leads to increased “project complexity”. Next, the distribution of technology and knowledge throughout the project’s organizational structure makes it more difficult to create understanding of the project as a whole (Veeneman, 2004). Accordingly, the distributed organization of EPRD projects creates “*structural uncertainty*”; the uncertainty that stems from the highly distributed technological and organizational project structure.

However the question remains how complexity and uncertainty related to each other. Does the complexity of large projects create uncertainty on their eventual outcome? Or does the uncertainty of specific project elements cause these projects to become increasingly complex? In fact there is a dual relationship between uncertainty and complexity. Uncertainty enhances complexity through innovations, while at the same time complexity hampers the understanding of the project as a whole, creating uncertainty. The fragmentation of a complex project makes it becomes more difficult to spot, control and coordinate its outcome as knowledge becomes scattered across the organization. The paradox is however that innovations and interactions are both important strategies for addressing complexity, and are essential for the project to succeed. This implies that a reduction of the number of interactions and innovations will proof to be ineffective when one attempts to minimize complexity. To create a better understanding of the drivers of risk in EPRD projects, a distinction is made between “*structural complexity*”, “*project uniqueness*” and “*structural uncertainty*” that together add to a more general perception of **project complexity**:

- **Structural Complexity**: Complexity rising from the differentiation of the project into separate subsystems and the increasing number of interactions between those subsystems
- **Project Uniqueness**: The uncertainty that rises from a lack of knowledge, requiring the development of innovative concepts, methods and technology.
- **Structural Uncertainty**: The uncertainty resulting from a lack of understanding of the project as a whole, resulting from both technological and organizational fragmentation.

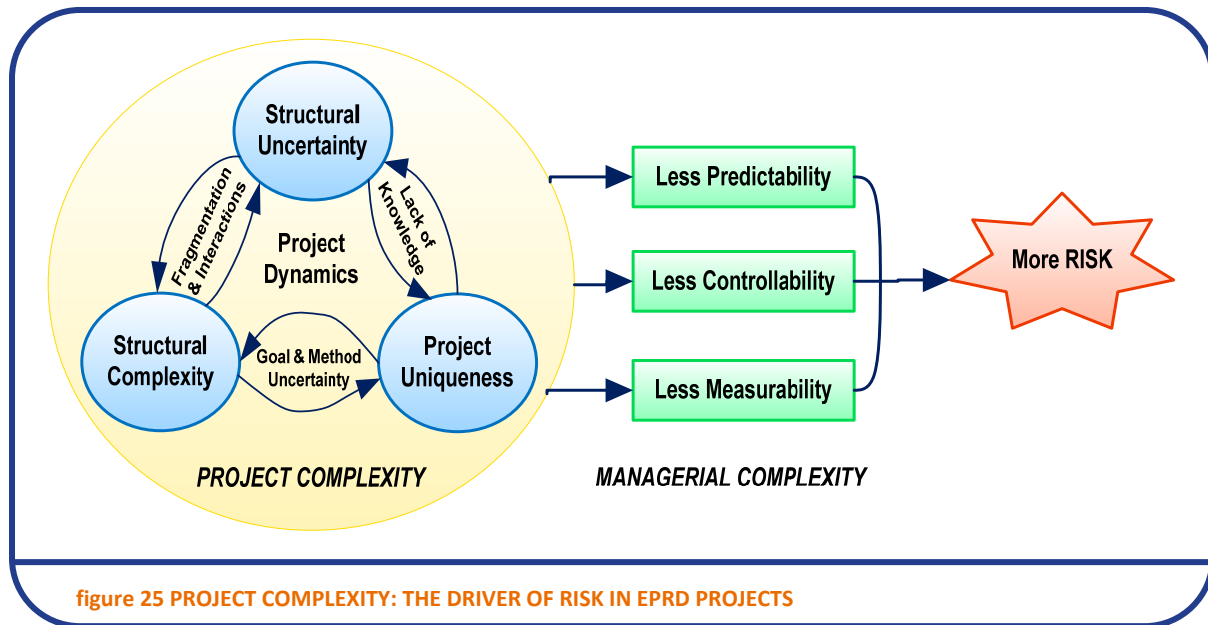
So far, the concepts of complexity and uncertainty have been discussed from a static point of view in order to create a better understanding of their relationship. However both complexity and uncertainty are in fact highly dynamic, continuously changing as the project proceeds. Understanding of the project’s goals, methods and technology is constantly build up and new interactions are

introduced on a daily basis (Veeneman, 2004). As a result, the level and focus of uncertainty within a project constantly shifts as project elements and sub-elements are finished or changed to suit new circumstances. Ollsen (2007) gives that today's projects are better described as "*journeys of exploration in a given direction, rather than strict plan-followed endeavors*". Both the project and its environment are highly dynamic, which adds to the concept of risk and complexity.

EPRD projects are considered to be highly dynamic, as a lot of the knowledge needed for the execution of the project is gathered along the way (Interview 2 and 27, see appendix N). The platforms that need to be removed have been exposed to the world's most extreme weather conditions for over 30 years. This makes it very hard to give solid assumptions on their condition and structural integrity. In addition, a lot of the platforms have been modified during their operational lifetime, of which there is very little or even no documentation. Platform drawings are in most cases outdated or unavailable. In many cases, the best way of getting the necessary information is by visiting the platforms (Interview 2 and 8, see appendix N). EPRD project require a lot of surveys of both the topsides and jacket structures to gather the necessary information for a safe and sound removal. Project Managers (Interview 2, 8 and 11, see appendix N) indicate that large removals require almost twice the amount of planning and engineering effort in comparison to installations. During the project, the scope of work constantly changes as new discoveries are made, which in most cases imply extra work. And because there is no single tried and tested method for removing a large jacket structure, the jacket removal concept is also subjected to many changes as different project parties collaborate on how to best cut and lift the platform's jacket.

Together, the complexity, uniqueness and dynamics of EPRD projects cause **managerial complexity** (see figure 25). Complexity reduces the manager's ability to *predict*, *control* and *measure* the outcome of the project (Veeneman, 2004). Summarizing the findings of the case study analysis, the uncertainty and risks affecting the performance of EPRD projects mainly stems from:

- **Less predictability:** The fragmentation of knowledge, technological innovations and the uniqueness of large EPRD projects together reduces their predictability. The many innovative elements in these projects not only cause problems, but spread these issues to other parts of the project as there are many connections between separate subsystems. Fragmentation of project information through specialized subcontractors and project teams further decreases the predictability of the project in advance. Adding to this effect is the lack of information on the structural integrity, marine growth, corrosion, damages, contamination and other aspects of the platform in the early phases of the project. This makes it very difficult to estimate the project's budget and schedule requirements in advance. Experience in offshore decommissioning might improve the predictability and performance of separate subsystems, but the complexity of interactions among these systems indicates that it will always remains difficult to predict project outcomes.
- **Less controllability:** The fragmentation of technology, subsystem interactions and the inherent dynamics of the project reduce the controllability of large EPRD projects from a manager's perspective. As many teams and specialized subcontractors have to work together in the project's hierarchical structure, it becomes more difficult to control the development of the project as many decisions have to be made along the way. Especially because success in EPRD project for HMC depends for a great deal on the performance of its subcontractors, there clearly is less controllability during the project's development and execution compared to more conventional projects.
- **Less Measurability:** The size of the project, increased complexity and a large project organization reduces the measurability of the project's status. For the project to be manageable from a top down perspective requires a simplification of the project's inherent complexity. However this might cause an underestimation of the effect of individual decisions on the project as a whole. Due to large scope and timeline of EPRD projects, it is very difficult to keep track of all the processes and developments that take place. Many problems will surface in later stages of the project's development, requiring managers to constantly shift their attention to the parts of the project where complexity emerges. This makes it very difficult to maintain oversight and make considerate estimates of the project's progress, while remaining a clear focus for effective managerial intervention.



From the perspective adopted in this thesis, the overall complexity associated with large EPRD projects drives risk, as it is not only more difficult to set objectives in the early phases of the project, but also to keep the project within these predefined boundaries. As a result, project management activities focus on better predicting, controlling and measuring the project's outcome (Veeneman, 2004). Traditional project management consists of making detailed plans of the project (planning, WBS, budgets) and then use almost all of the management capabilities to keep these plans under control. However the characteristics of complex projects indicate that further and further planning will eventually give a decreasing return, because if the plan is too rigid and complicated it will be unable to cope with change. Turner (1998) gives that *"in the end, you will have to stop planning and start managing the risks"*. Effective risk management practice is therefore crucial in complex and innovative projects, as it addresses the issues of complexity and uncertainty in a proactive manner. Project risk management thereby focuses on uncertainty that matters, and in doing so significantly increasing the chance of project success.

4.5 The benefits and importance of explicit project risk management

Project management is the industry's standard for managing large technological projects, defined by Kerzner (2003) as *"The planning, organizing, directing and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives"*. Pollack (2007) indicates that traditional project management methods have been strongly influenced by the *"hard paradigm"* (positivism/realism), emphasizing on *"control against predefined goals"*. Veeneman (2004) support this idea and indicate that project management entitles the means to *control* the project along the lines of previous *predictions*.

These predictions are made during the early phases of the project's development, concerning the product (design), costs (budgets), tasks (work breakdown) and schedule (planning) of the project. Next, the main task of project management is to keep the project within these predefined boundaries, making sure that the initial estimates eventually align with the project's result. Consequently, the common perspective of failure in large projects follows this line of reasoning: bad planning, flawed design, insufficient budget, bad execution of tasks and weak management. (Veeneman, 2004). In other words, initial estimations were wrong and we will need to develop better methods to keep the project under control.

4.5.1 Why traditional project management fails in complex projects

As the complexity and scope of today's projects increases, it becomes far more difficult to provide adequate predictions, as well as controlling them. Recent research indicates that classical project management techniques are unsuitable for dealing with complex projects, and that a different perspective is required (Pollack, 2005; Veeneman, 2004; Crawford, 2004; Williams, 1999).

The uniqueness of a project's scope, technology and context makes it increasingly difficult to develop solid predictions and set realistic objectives. Moreover, the increasing rate at which markets, technologies and the environment continues to change makes it even more difficult to make solid predictions in advance. Hence one might question the ability to provide good predictions of complex projects on beforehand, as many aspects of the project are still unknown and will undoubtedly change. Past experience is less useful in making estimates of complex projects as they are often highly unique, and decomposing the project into smaller parts neglects the compounding effects of their interactions. Veeneman (2004) indicates that projects are increasingly time-constrained, because the ability to deliver a project faster than its predecessor has become an important element in winning a bid. The shift of risk responsibility from client to contractor further increases the scope and structural complexity of today's projects (Williams, 1999). Competitive bidding procedures are more often used for procurement processes, thereby giving contractors an extreme incentive to keep their prices low (De Bruijn et al., 2002).

As previous sections of this chapter have argued that risks in EPRD projects mainly stem from increased complexity and the project's uniqueness, it may be concluded that merely adopting the "hard" project management approach is considered to be ineffective. Murray Webster and Simon (2007) indicate that one needs to adapt its management style by mixing both "hard" and "soft" elements of management to suit the specific demands of complex projects. Research on the management of large technological projects confirm these findings, showing that project success in complex projects requires an expansion from the hard to the soft paradigm (Pollack, 2005; Veeneman, 2004; Crawford, 2004; Williams, 1999). Success in complex projects depends to a bigger extent on the ability of project players to effectively work together. Predictions and control are more about building commitment and thrust than to create an accurate and precise project plan. Consequently, the project's manager is no longer considered to be the one person at the top of the hierarchy who has the power to manage each and every project risk. Rather he takes on the role of a facilitator, organizing mutual control and risk responsibility among all important stakeholders. Project management should therefore focus on creating both resilience and flexibility within the project's organization. This makes the project able to cope with uncertainty and dynamics, thereby improving the effective realization of project plans.

4.5.1 The benefits of explicit PRM in EPRD projects

As EPRD projects are more complex, unique and subject to increased dynamics, it becomes more difficult to make solid predictions in advance and keep the project's budget and schedule under control. Consequently, these projects are considered to be more risky than conventional installation projects, where HMC can use its experience and high standards to manage risk along the way. It can be concluded from the case study that many aspects of the project are new to HMC, which makes it far more difficult to rely on past experiences.

Explicit PRM is considered to be a valid approach to increase the chance of success in complex EPRD projects, as it is all about understanding the sources of uncertainty that affect project objectives. PRM techniques use the knowledge of the entire organization to identify risks (both positive and negative), and create effective strategies for their management. This increases the flexibility of projects plans, ensures effective communication between key project parties, and assists management to keep a focus on the issues that really matter.

Risk management in EPRD projects should be continuous and explicit, central to decision-making throughout the entire project lifecycle. When performed effectively, PRM creates more realistic project budgets and schedules in the initial phases of the project, and puts the necessary actions in place to minimize the occurrence of risks as the project proceeds. Furthermore, PRM creates a better understanding of how uncertain parts may affect the project as a whole. Risk management software can be used to simulate the project in the face of risk and show the effect of uncertainty on project outcomes.

Explicit risk management therefore brings far-reaching benefits to the management of complex EPRD projects. Explicitly discussing risks creates thrust, openness and transparency among the various project parties. Possible problems and social conflicts are addressed proactively, so the right actions can be taken to prevent these from occurring in the first place. Furthermore, PRM assist in making better decisions, enabling a more objective comparison of alternatives. It improves understanding of the responsibility that each party has in the project's organization, and a more efficient distribution of valuable project resources. Consequently, there are both hard and soft benefits to explicit PRM. Research by the APM Risk SIG in 1996 produced a list of soft and hard benefits than are shown in table 2. Additional benefits of PRM that affect other parts of the organization are given by Hillson and Simon (2007), which can also be seen in table 2.

table 2 Benefits of Project Risk Management, (APM PRAM, 2004)

"HARD" BENEFITS OF RISK MANAGEMENT	"SOFT" BENEFITS OF RISK MANAGEMENT
Enables better informed and more believable plans, schedules and budgets	Improves corporate experience and general communication
Increases the likelihood of the project adhering to its schedules and budgets	Leads to a common understanding and improved team spirit
Leads to the use of the most suitable type of contract	Helps distinguish between good luck/good management and bad luck/bad management
Allows more meaningful assessment of contingencies	Helps to develop the ability of staff to assess risks
Discourages the acceptance of financially unsound projects	Focuses project management attention on the real and most important issues
Contributes to the build-up of statistical information to assist in better management of future projects	Facilitates greater risk-taking, thus increasing the benefits gained
Enables a more objective comparison of alternatives	Demonstrates a responsible approach to customers
Identifies, and allocates responsibility to, the best risk owners	Provides a fresh view of the personnel issues in the project
ORGANIZATIONAL BENEFITS OF RISK MANAGEMENT	
Compliance with corporate governance requirements	Better reputation as a result of fewer headline project failures
A greater potential for future business with existing customers, greater competitive advantage	Better customer relations due to improved performance on current projects
Reduced cost base	A less stressful working environment

4.6 Summary and conclusions

Summarizing, the shift in risk responsibility and large project scope for HMC creates the need for more explicit PRM activities. Transparency of risks is crucial to create mutual responsibility and commitment between all different project parties. The organizational complexity of EPRD projects creates the need for collective responsibility on risks, as it is no longer possible for the project manager to oversee, coordinate and control all the risks that affect the project. Neither is it possible

to simply offload risks to external parties as HMC remains responsible for their effects as the project's main contractor. The inherent dynamics of EPRD projects require a continuous collaboration on risks along the entire project lifecycle. Furthermore, the structural uncertainty and complexity of EPRD projects requires the acknowledgement of risks in schedules and budgets, to ensure there is enough flexibility to cope with changes as the project proceeds.

However the most important reason for explicit PRM in complex EPRD projects is because it significantly increases the chance of project success. Empirical studies have shown that effective PRM increases the probability that the project stays within the budgeted cost, the allocated time period and with acceptance of the client. Research by Elkington and Smallman (2002) indicates that there is a strong link between the amount of risk management undertaken in a project, and the level of success of the project; "More successful projects use more risk management". Another study by Raz and Michael (2001) within the high-tech industrial sectors indicates that on a five point scale, PRM scores a 3.94 in its contribution to "Overall Project Success". Furthermore, empirical results from research by Terry Cooke-Davies (2005) on data from over a 100 projects across a variety of industries indicates that projects where risk management was rated "not at all adequate" were completed on average at a 170% of the plan. While project that rated their risk management processes "fully adequate" are completed at 95% of the initial project plan. Where the management of risk is ineffective, a project can only succeed if the project team is lucky. However explicit PRM optimizes the chances of the project succeeding as planned, even in the face of bad luck.

Chapter 5

"As we know, there are **known knowns**
 These are things we know we know.
 We also know there are **known unknowns**
 That is to say we know there are
 some things we do not know;
 but there are also **unknown unknowns**
 the ones we don't know we don't know...
 It is the latter category
 that tend to be the difficult ones"

Donald Rumsfeld

5.1 Risk Management Theory

5.2 Uncertainty vs. Risk

5.3 The PRM process

5.4 Best Practice PRM process: The ATOM Methodology

5.5 Summary and conclusions

5. The PRM process



The preceding chapters have argued the need, benefits and importance of explicit risk management in EPRD projects. As these large removal projects differ significantly from the more conventional installations HMC has executed so far, they require a more deliberate focus on PRM to ensure effective performance. The scope for HMC as a main contractor together with an overall lack of experience in large removal projects gives rise to the heightened risk profile of EPRD projects.

Until this point there has been little focus on the theoretical principles of risk and the management thereof. This chapter will therefore focus on exploring the theory of PRM, providing a general framework for the analysis of HMC's risk management process. Commonalities and differences between various PRM standards are compared in terms of their *scope*, *process steps* and *specific emphasis*. The following research questions will be discussed and answered:

2.1 What does the process of project risk management look like?

2.2 What is "best practice" project risk management?

The information provided in this chapter is based on an extensive review of practical PRM handbooks, guidelines and other documents that prescribe how one should perform PRM in practice. Detailed information on the studied documents can be found in appendix K. The definitions of "project risk" and the "risk management processes" of eight (inter)national and professional risk management standards are compared. The aim of this chapter is to create a better understanding of what is perceived to be the current "best practice" in the field of PRM.

5.1 Exploration of Risk Management Theory

Section 5.1 will first give an introduction in the history of risk and the development of theories on the subject of risk management. Next, the selected documents for the literature review are introduced, with the focus of the comparative analysis on "best practice" PRM.

5.1.1 Brief introduction to Risk Management

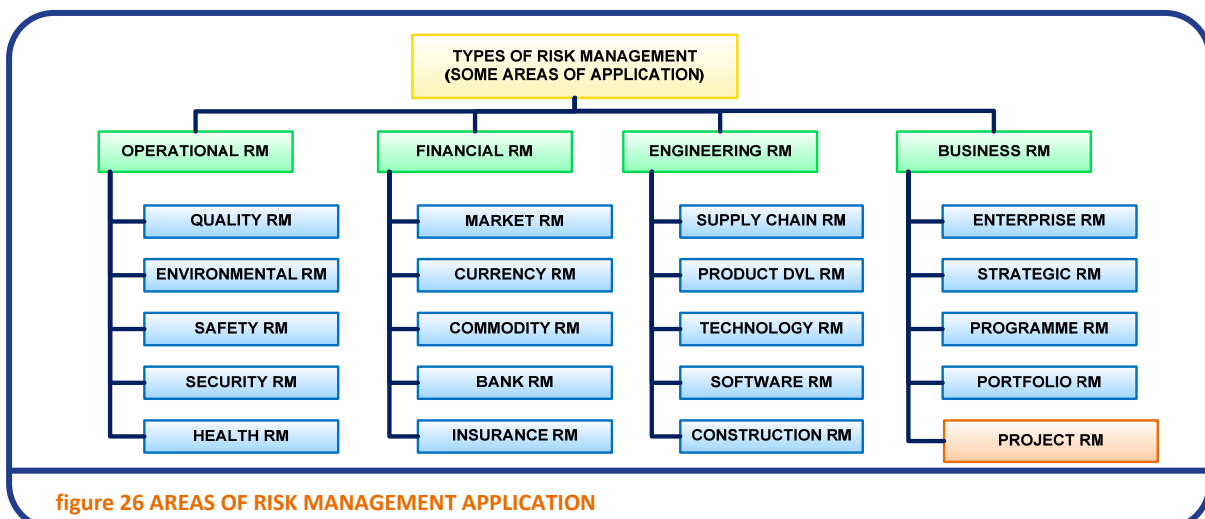
The concept of risk has been known to humanity since the beginning of recorded history. Around 400 BC, Plato stated that *"The problem with the future is that more things might happen than will happen"*. Nevertheless, mankind has always been fond of taking risk, giving the fact that gambling (the very essence of risk taking) has been a popular game throughout all times. For some reason, people perceive themselves more faithful than others in the face of risk, having the idea that luck (and the odds of victory) is on their side. Adam Smith (1776) even stated that mankind's tendency

towards risk-taking behavior has fueled the world's economic development, giving that *"the overweening conceit which the greater part of men have of their own abilities and their absurd presumption in their own good fortune"*. However for a long period of time, risks were taken without any underlying system or logic (Bernstein, 1996).

The Hindu-Arabic numbering system forms the basis for the modern idea of risk, reaching the West a mere 700 to 800 years ago. But it took until the Renaissance, before any serious attempts were made at the studying of risk. In 1654, Blaise Pascal and Pierre de Fermat came up with the *Theory of Probability* when they tried to solve an ancient problem related to gambling. Bernoulli later advanced this theory by introducing the concept of utility (a measure for the consequences of risk) in 1738, founding the *Utility & Decision Theory*. Further contributions to the theory on risk were made by Abraham de Moivre (1750) who discovered the concept of *Standard Deviation* and *The Normal Distribution*. Basically, all of modern risk management theory finds its origins with these discoveries. Except for the revolutionary ideas of Harry Markowitz in 1952, who demonstrated that putting your eggs in one basket is an unacceptable risky strategy (Bernstein 1996). Markowitz ideas significantly altered risk-taking in today's businesses, introducing a new way of thinking in modern economics and portfolio risk management.

However the origins of modern risk management theory stem from developments in the aerospace, nuclear and chemical sectors where the heightened safety risks required a new approach. Events like the failed Apollo AS-204 test (1967), the Challenger incident (1986) and the Chernobyl disaster (1986) have significantly altered decision-making in the face of risk. These catastrophes resulted in the development of "numerical" safety goals in the late 1980s and 1990s, which caused major advances in the field of risk analysis. In 1986, the ALARP-principle (As Low As Reasonably Possible) was introduced into a numerical framework, using risk factors and risk classification to support decision-making in hazardous situations.

The success of risk management within the discipline of safety engineering has quickly spread to other industries and business sectors, propelled by the world's increasingly turbulent business environment, rapid technological advances and a continuing trend towards globalization. Consequently, risk analysis and risk management are currently applied within a large variety of business sectors, including transport, construction, energy, chemical processing, the military and more recently the field of project and financial management. The growing importance of risks in our society and the way risk affects decision-making in our businesses has resulted in a growing number of different types of risk management. Up until now, there exists no commonly accepted framework for the classification of different areas of risk management, however one might distinguish between *Operational* (safety RM, security RM), *Financial* (market RM, insurance RM), *Engineering* (software RM, construction RM) and *Business* (Strategic RM, Project RM) (see figure 26).



One area of application where risk management is gradually conquering more terrain is the field of Project Management, where the theory of risk management is used to make projects more resilient towards uncertainty and risk. Recently, the Project Management Institute (PMI, 2000) has included risk management into their nine pillars of Project Management practice. As a consequence, there have been a growing number of books, guides and professional standards that prescribe how organizations should manage their project's risks.

5.1.2 Review of PRM literature

For the literature review of this thesis, 17 risk management standards and guidelines have been selected, focusing on the specific field of PRM. These standards consist of 10 (inter)national standards that were developed by standardization bodies, and 7 standards that were developed by professional organizations that have an interest in risk management (see appendix K). All of these were published within the last two decades, of which the earliest publication dates back to 1992. Additionally, a number of handbooks and guidelines have been consulted that specifically focus on the subject of PRM practice. Writers like Hillson and Simon (2007), Cooper et al. (2005) and Chapman and Ward (2004) have made valuable contributions to the scientific knowledge base of PRM. Furthermore, Project Management literature has been reviewed on the subject of Risk Management, as many PM handbooks have a separate chapter devoted to the management of risk. An overview of the studied documents for this thesis is shown in table 3, of which a more detailed elaboration can be found in appendix K.

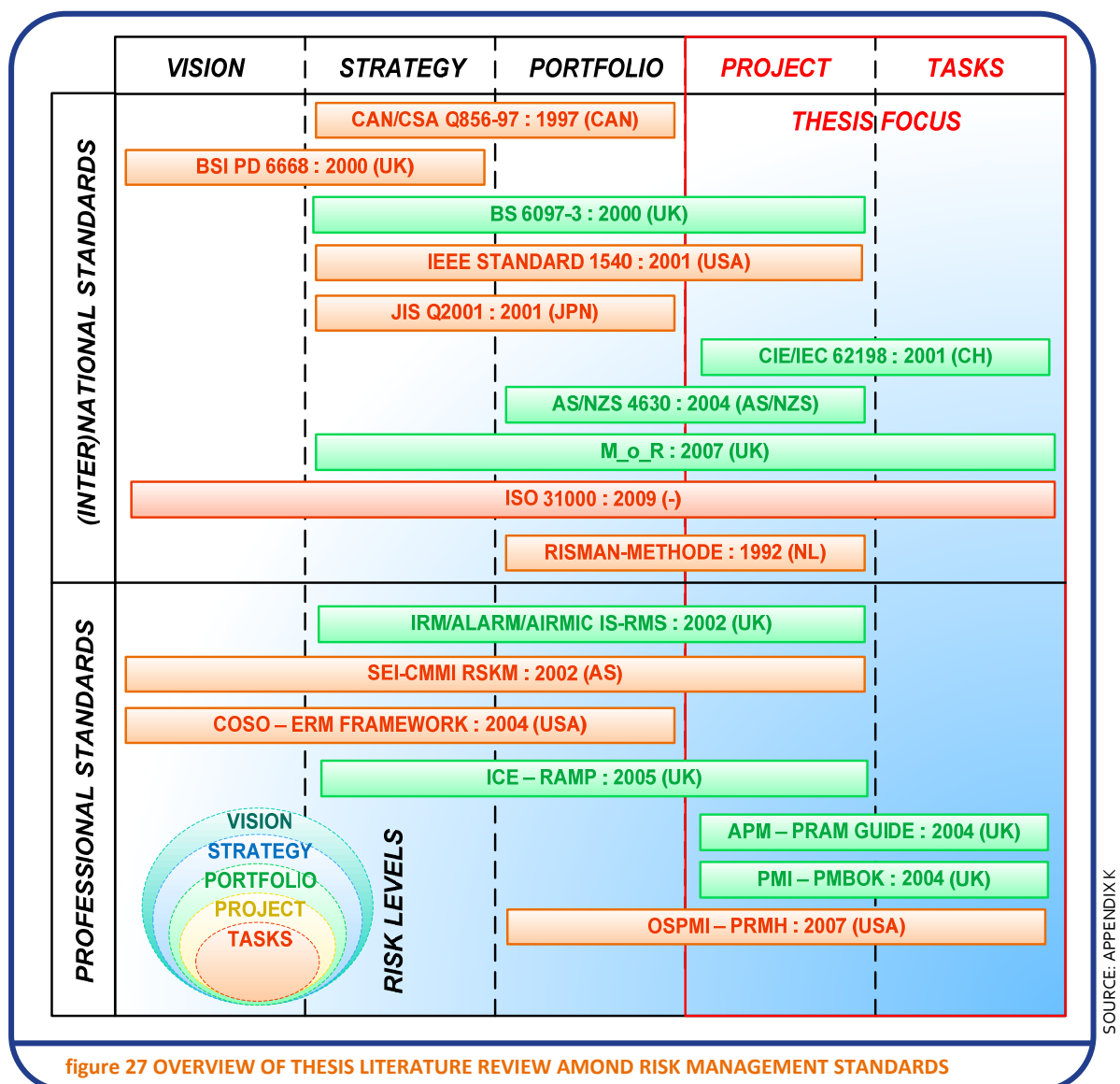
table 3 Documents used for literature review of PRM

LITERATURE CATEGORY	GENERAL REVIEW	COMPARATIVE ANALYSIS
International Standards on Risk Management	UK: BSI PD 6668 (2000) USA: IEEE 1540 (2001) JPN: JIS Q2001 (2001) CAN/CSA: Q859 (1997) ISO 31000 (2009) NL: RISMAN (1992)	UK: BS 6097-3 (2000) AS/NZS: 4630 (2004) CIE/IEC: 62198 (2001) UK: M_o_R (2007)
Professional Standards on Risk Management	USA: COSO (2004) AS: SEI RSKM (2002) USA:: OSPMI (2007)	UK: IRM/ALARM/AIRMIC (2002) UK: ICE RAMP (2005) UK: APM PRAM (2004) USA: PMI PMBOK (2004)
Practical Guidelines on Project Risk Management	Hillson and Simon (2007) – ATOM Methodology Cooper et al. (2005) – Project Risk Management Guidelines Chapman and Ward (2004) – Project Risk Management Loosemore et al. (2006) – Risk Management in Projects Kliem and Ludin (1997) – Reducing Project Risk	
Project Management Literature	Kerzner (2003), chapter 17 – Project Management Nicholas (2004), chapter 10 – Project Management for Business & Technology Butrick (2005), chapter 24 – The Project Workout Dinsmore et al (2004), chapter 14 – AMA Handbook of Project Management Meredith and Mantel (2006), chapter 4.6 – Project Management	

For a more detailed analysis, a further selection of the RM literature is made by their specific scope and focus. According to Raz and Hillson (2005), risk management standards differ in terms of their scope and associated level of implementation within organizations. A distinction can be made between several levels of risk management implementation: visionary, strategy, portfolio, project and tasks (Hillson, 2004). This distinction is based on whether the specific standards state that the process, steps and procedures it contains are meant to be used at a company-wide or project specific level. Hence some RM standards are specifically designed for the management of projects in a single industry, while others are far more generic and can be applied to a variety of management levels and industries.

As this thesis focuses on the management of risk within complex EPRD projects, a number of guides and standards were excluded from the comparative analysis due to their limited scope or differing level of application (see figure 27). The *BSI PD 6668:2000: Managing Risk for Corporate Governance* (BSI, 2000) is limited to addressing risk elements of corporate governance requirements, as is the *Enterprise Risk Management Framework* (COSO, 2004) which purely focus on the strategic management of enterprise risk. Other guides that are excluded because of their focus on an organizational level rather than on a project level are the *CAN/CSA-Q859-97 Risk Management: Guideline for Decision-makers* (CSA, 1997) and the *JIS Q2001 Guidelines for Development and Implementation of Risk Management System* (JSA, 2001).

The *IEEE Standard 1540-2001 for Software Life Cycle Processes Risk Management* (IEEE, 2001) and the *CMMI RSKM* (SEI, 2002) limit their scope to risk management within the software industry. The same applies to the *CEI/ICE 62198:2001 standards*; however it states on page 11 that “*This International Standard is applicable to any project with a technological content*” and will therefore be included (Raz and Hillson, 2005). Furthermore, the *OSPMI Project Risk Management Handbook* (OSPMI, 2007) and the *RISMAN-method* (RWS, 1992) share an explicit focus on large infrastructural projects within the US and the Netherlands. The *ISO 31000 Risk Management Principles and Guidelines on Application* (ISO, 2009) has not been used for the analysis within this thesis because it is still under construction. Consequently, a comparative analysis is made among eight risk management standards that share a focus on the management of risks within projects (see table 3).



5.1.3 Defining PRM – Towards “Best Practice”

In simple words, “*risk management is the art/science of attempting to understand and manage that which has not happened yet*” (Hillson and Simon, 2007). But what do we actually mean by this, and how does it apply to the management of projects? This seems to be a difficult question to answer as both “risk” and “management” are terms that are very hard to define. A number of PRM definitions are given from the standards that have been reviewed:

- “The systematic **process** of planning for, identifying, analyzing, responding to, and monitoring **project risks**” (M_o_R, 1997)
- “The **process** concerned with identifying, analyzing and responding to **project risk**” (PMI, 2004)
- “**Proactively** identify, assess and manage risks, to minimize potential threats and maximize opportunities that affect project objectives” (ICE, 2005)
- “Addressing **proactively** the implications of uncertainty on the achievement of project objectives” (Hillson & Simon, 2007)
- “**process** which enables the analysis and management of **risks associated with a project**” (APM, 2004)
- “The art and science of planning, assessing (identifying and analyzing), handling, and monitoring actions leading to future events to ensure favourable outcomes” (Hall, 2004)
- “The systematic application of **management** policies, **processes** and procedures to the tasks of establishing the context, identifying, analysing, assessing, treating, monitoring and communicating of **project risk**.” (Cooper et. al., 2005)

From these definitions, it can be concluded that PRM is commonly perceived as a **process** for the systematic management of **project risks**. Within this process, several steps, tools and techniques will help the project manager and project team to maximize the chance of meeting project objectives in the face of uncertainty. Risk management creates a greater opportunity for the project to succeed under the ever-tightening constraint of time, cost and scope.

Another important aspect of PRM is that it is **proactive** in nature, thereby fundamentally different from crisis management which is *reactive*. Risk management is concerned with future events, of which the exact outcome is still unknown.

However “Best Practice” PRM consist of the most *efficient* and *effective* way of managing project risk, based on repeatable procedures that have proven themselves over time for a large number of people (Hillson, 2004). It is therefore about the routine activities that lead to excellence, widely accepted and supported by leading professionals and practitioners. So best practice does not imply “*what everyone does*”, but “*what everyone should do*”. Accordingly, Hillson (2004) states that the most important elements of Best Practice PRM are considered with the right definition of “**Project Risk**” and the specific components that make up the “**Risk Management Process**”.

5.2 Uncertainty versus Risk

To answer research question 2.2 (What is best practice project risk management?), this chapter will continue with a comparative analysis of the widely accepted definitions of *project risk* and the particular steps that make up the *risk management process*. The eight selected RM standards will be reviewed and compared regarding their differences and similarities. A more detailed summary of risk management terminology and risk management processes that have been reviewed can be found in appendix K.

Generally, people associate the word risk with danger (Murray-Webster and Simon, 2007). When looking up the word “risk” in a dictionary, one will find its meaning explained as “*the possibility of suffering harm or loss*” (AHD, 2003). Therefore, in everyday language risk is often used as a synonym for the word *danger*. However in a more technical language, risk is used in a more quantitative sense, representing a numerical value with a certain probability of occurrence and expected impact. Not

surprisingly, the use of the word risk for different things is bound to give rise to problems and miscommunications.

At present, practitioners and professionals have been engaged in an active debate on the precise scope of the word “risk” (Hillson and Simon, 2007). This “definition debate” focuses on two major issues. The first issue addresses risk versus uncertainty. Many people get confused between the terms risk and uncertainty, as both have corresponding characteristics. However risk is not the same as uncertainty. So what exactly is the difference between them and how do they relate to each other? The second issue of the debate is about the existence of “positive risk”. Traditionally, the emphasis and perception of risk has always been on the negative side, characterizing risks as harmful, adverse, negative and unwelcome. However the potential effects of uncertainty might also be positive, and thereby beneficial and welcome. When risk is used in this way, it can be seen as an opportunity instead of a threat.

Accordingly, these two issues will be discussed in the light of the PRM literature that has been reviewed. As Hillson and Simon (2007) indicate that there currently is a paradigm shift in the field of PRM, where the difference between general uncertainty and risk is being clarified and the concept of risk has expanded towards the inclusion of both threats and opportunities.

5.2.1 When is a Risk not a Risk?

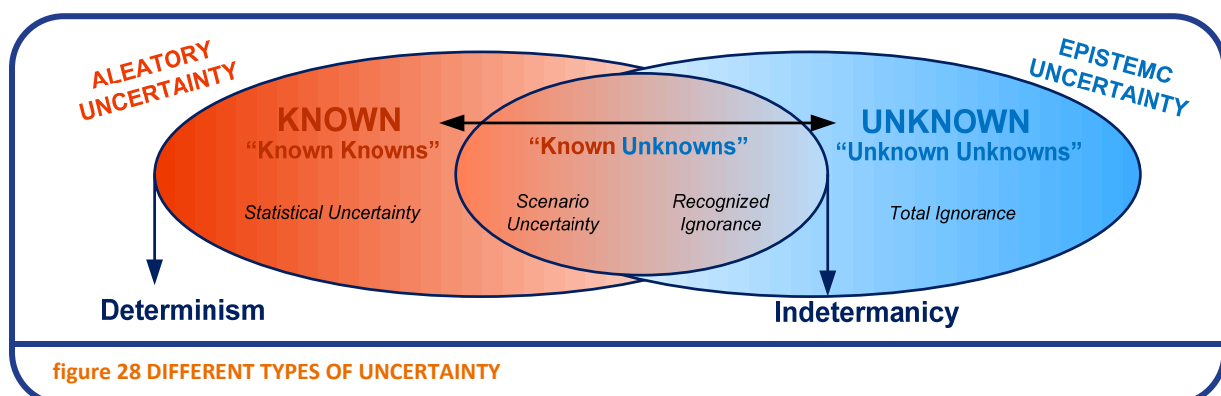
Uncertainty and risk are two different, but highly interrelated concepts. Hence the difference between risk and uncertainty is not that obvious, and requires a more detailed elaboration.

The first attempt of defining uncertainty came up in the science of psychology, where Herbert Simon (1947) wrote that man has certain limits to its cognitive ability. This introduced the concept of “bounded rationality”, giving that the ability of people to make rational decisions is hampered by their cognitive limits. But what do we mean with uncertainty, apart from “the lack of complete certainty”?

A number of studies attempted at answering this question, focusing on the source of uncertainty. A general distinction is made between *aleatory uncertainty* and *epistemic uncertainty* (Ollsen, 2007).

The aleatory dimension of uncertainty has to do with chance, resulting in *variability*. Variability is what makes the world uncertain and unpredictable, caused by the inherent randomness of nature and human behavior (van Asselt, 2000). This makes it impossible to foresee what will happen in the future.

Epistemic uncertainty is concerned with the uncertainty that rises from a *lack of knowledge*. The variety in the amount of knowledge “lacking” allows uncertainty to be classified into several levels (Walker et. al, 2003). Ranging from *statistical uncertainty* (inexactness) to *total ignorance* (indeterminacy), see figure 28.



If we are able to classify different types and levels of uncertainty, then what do we consider being a risk? Hillson (2004) gives that the key in separating the term risk from uncertainty is that risk always relates to objectives. The simplest definition of risk is therefore “**uncertainty that matters**”, because a risk has the possibility to affect one or more objectives. As risk arises from the interactions of uncertainty and objectives, the following general definition of risk is given:

- *“Any uncertainty that, if it occurs, would have an effect on the achievement of one or more objectives” (Hillson and Simon, 2007)*

This definition recognizes the fact some uncertainties are not important in the light of achieving objectives and are therefore not considered to be risks. For example, if you are installing an IT-system in Australia, the uncertainty about whether it is going to rain tomorrow in New York is irrelevant. But if the project consists of construction work in the streets of Manhattan, the possibility of rain is not just any uncertainty but a serious risk that affects the project’s objectives. Linking risk with objectives makes it clear that life, business and projects are always risky. Everything we undertake has the aim to achieve a certain objective or perceived benefit. And as these objectives are always affected by the inherent uncertainty of the future, there will be risks to their successful achievement. Moreover, the link between risk and objectives makes it possible to distinguish between various levels of risk, based on the different types and levels of objectives within an organization. Every organization has strategic, technical, reputational, operational etc. objectives; hence uncertainty that affects these objectives causes strategic, technical, reputational and operational risks.

Another important characteristic of risk is that it focuses on future events. Past events like problems, issues or a crisis are no examples of risk. Besides costs, people and places can neither be seen as risks because they are no events. However, a person might execute a future event at a particular place, affecting cost objectives or project performance. Common non-risks that are often confused with risks are (Hillson and Simon, 2007):

- **Issues.** Issues are matters of concern that affect a project, but are not characterized or defined in a way that they can be treated as risks. Issues are therefore vaguer than risks, and may indicate a specific area of concern from which risks may arise. Like the weather conditions or the availability of resources. Furthermore, people sometimes refer to issues as events that have occurred and require the attention of the project’s manager. From this point of view, issues are the negative results of risks that have happened.
- **Problems.** Problems are risks that have actually occurred (just like issues), and require immediate attention. Consequently if a risk is not properly identified and managed in the earlier stages of the project, it might easily become a problem when the project is well on its way. The difference between a problem and an issue is that issues take more time to fix, but the solution is clear as soon as you encounter the issue. Problems however are potential issues, of which the right solution is not that obvious when the problem is discovered. More effort and elaboration is needed for problem-solving.

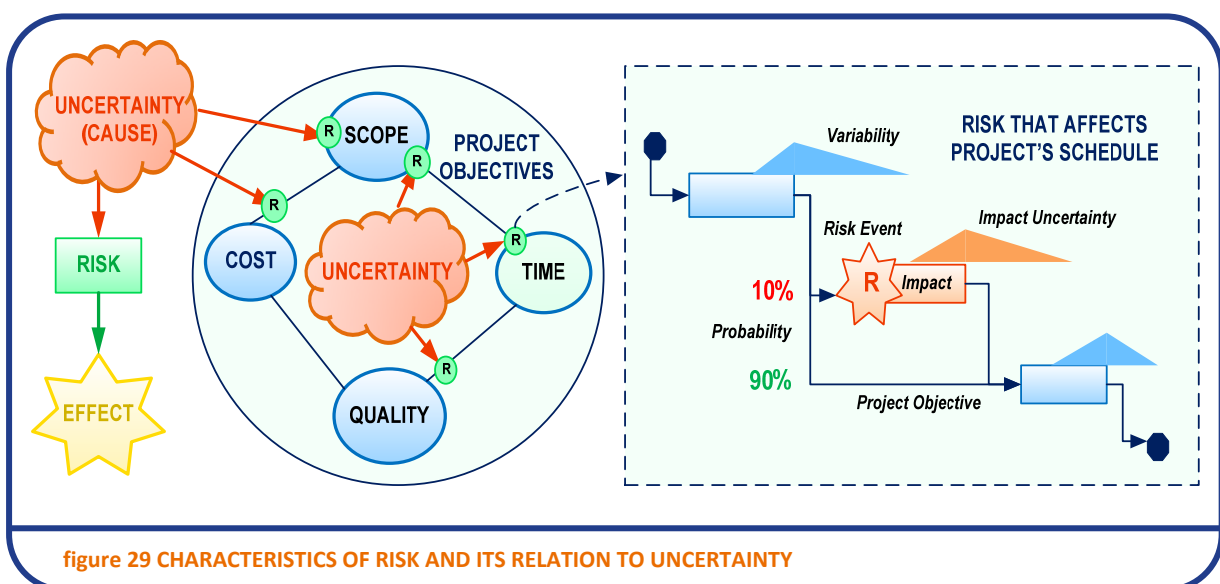
Separating risks from non-risks is crucial to effective risk management and often causes confusion among parties who try to manage their risks (Hillson, 2004). In order to do so effectively, it is important to distinguish between the causes of risk, the risk event itself and the eventual of risk when it occurs (Hillson and Simon, 2007).

- **Causes of risk:** Causes of risks are definite events or sets of circumstances which exist in a project or its environment, and which give rise to uncertainty. These facts have a positive influence on the risk event taking place. Each risk might have several causes, and one cause might influence multiple risks. For instance the need to use innovative technology, the responsibility for coordinating subcontractors and the fact that HMC has never done large EPRD projects before, are all causes of risk in EPRD projects. However the causes themselves are not uncertain, and therefore not considered to be risks.

- **Risk events:** Genuine risks are uncertain events that if they occur, would affect the achievement of objectives. Risks are therefore real events that might take place in the future. Examples of risks are changes in the client's requirements, late delivery of subcontractors, or the failure of subsea cutting tools that can all be managed proactively. It is important to indicate that risks might either take place or not. There is no "half" occurrence of a risk, however the effects of a risk that has happened might vary and can be uncertain. Risks should therefore be described as single events, and not as a broad category of events. The risk of "bad weather" is therefore too broadly defined, whereas the risk that the SSCV has to move to shallow waters because of bad weather is.
- **Effects of risk:** Effects of risks are the unplanned variations from the project's objectives that result from the risks that actually occur. So exceeding the initial budget, failing to meet contractual requirements or a delay in the planning are not risks, but the result from risks that have happened.

Consequently, risk is not the same as uncertainty and should be separated from its causes and effects. Hence, the "Known Knowns" are not considered to be risks, as we are certain that these events will take place in the future (see figure 29). However we might be uncertain of their outcomes because of the world's natural randomness, e.g. variability. "Unknown Unknowns" are neither considered risks because it is impossible to identify and specify events that are completely unknown to everyone. But as the project progresses, some of the unknown unknowns might become known, and give rise to new risks that can be managed. Accordingly, genuine risks result from the grey area in between that what we know and what we don't know, or never will know, e.g. the "Known Unknowns" (see figure 29). Risks are future events that rise from uncertainty, with a certain cause and effect on objectives. This makes it possible to quantify and measure risk in terms of its "probability" (chance of occurrence) and "impact" (effect on objectives). Each project risk has a certain probability between 0% and 100%, and a perceived impact (delay, cost) on project objectives. However one might be uncertain about the magnitude of this impact if the risk occurs, which causes additional uncertainty, e.g. impact uncertainty (see figure 29)

PRM is about acknowledging the fact that each project is surrounded by uncertainty that causes risks. During risk identification, it is important to be aware of the specific circumstances and uncertainties that cause risk events that might affect the project's objectives. By clearly separating a risk from its causes and effects, one might create effective responses in order to reduce the risk's probability or impact.



5.2.2 Inclusion of “positive risk”

For many years, risks have been thought of as being bad, negative and potentially threatening to the realization of objectives. This may stem from the fact that we often use the word risk as a synonym for the word danger in our every-day conversations. Consequently, we are programmed to think negatively about risks (Cooke-Davies, 2005). From this association, PRM would seem to be about identifying and managing the threats that affect a project’s performance. However this view is restrictive because it does not consider the potential welcome effects of uncertainty, e.g. opportunities. Current thinking in the field of PRM has expanded the concept of risk to include both “down-side” and “upside” risk (Hillson and Simon, 2007; Perminova et al., 2008; Olsson, 2007). From the definition of risk as “*any uncertainty that, if it occurs, would have an effect on the achievement of one or more objectives*” it is possible to distinguish between negative and positive effects on objectives. This means that there are also uncertain events that, if they would occur, would have a beneficial effect to the outcome of the project. When risk is used in this way, PRM should be as much about preventing threats from happening, as well as enhancing the possibility and impact of opportunities.

Recently, the PRM community has been in debate on whether the definition of risk should include both upside risk (opportunity) as well as downside risk (threat) (Hulett et al., 2002). Some insist that the traditional approach should be upheld, where the term “risk” refers exclusively to the uncertainties with negative consequences. While others favor a broader definition of the word risk to include both negative and positive consequences, widening the scope of the PRM processes to address both threats and opportunities.

Table 4 shows the definitions of the term “risk” used in the PRM standards selected for the literature review. A division is made into three groups: negative, neutral and broad definitions of project risk. The negative definition exclusively indicates that risks are bad, and threatening to objectives. The more neutral definitions do not explicitly state whether the consequences could be positive or negative. And the broad definitions of risk include both threats and opportunities.

table 4 Comparison of Risk Management Definitions

NEGATIVE DEFINITION	NEUTRAL DEFINITION	BROAD DEFINITION	
CAN/CSA- Q850-97 : 1997 ‘the chance of injury or loss ’	BS6079-3 : 2000 ‘Uncertainty ... that can affect the prospects of achieving ... business or project goals’	ICE – RAMP : 2004 ‘A threat (or opportunity) that could affect adversely (or favorably) achievement of the objectives of an investment’	AMA PM HANDBOOK : 2004 “An uncertain event or condition that, if it occurred, would have a positive or negative effect on a project’s objectives”
IEEE 1540 : 2001 ‘the likelihood of an event, hazard, threat or situation occurring and its undesirable consequences ; a potential problem ’	IEC 62198 : 2001 ‘Combination of the probability of an event occurring and its consequences for project objectives’	IRM/ALARM/AIRMIC : 2002 ‘combination of the probability of an event and its consequence ... consequences can range from positive to negative ’	PMBOK : 2004 ‘an uncertain event or condition that, if it occurs, has a positive or negative effect on a project objective ... includes both threats to the project objectives and opportunities to improve on those objectives’
BSI PD 6668 ‘risk ... hazard x consequence”	JIS Q2001 (E) : 2001 ‘a combination of the probability of an event and its consequence ’	PRAM Guide : 2004 ‘an uncertain event or set of circumstances which, should it occur, will have an effect on achievement of ... objectives ... either positively or negatively	ATOM : 2007 ‘any uncertainty, that, if it occurred, would have a positive or negative effect on the achievement of one or more objectives’
COSO – ERM : 2004 ‘... event with a negative impact, which can prevent value creation or erode existing value.	ISO 31000 : 2009 ‘Risk is the combination of the probability of an event and its consequences ’	M_o_R : 2007 ‘An uncertain event or set of events ... will have an effect on the achievement of objectives. A risk is measured by a combination of the probability of a perceived threat or opportunity occurring ... on objectives’	AS/NZS 4360 : 2004 ‘the chance of something happening that will have an impact upon objectives. Combination of the probability of an event and its consequence... which can range from positive to negative ’

It is interesting to see that the risk management standards that focus on the management of project risks (selected in section 4.1.2) adopt a broader definition of the word risk, while the standards that have a different scope adopt a more traditional or neutral definition of risk. As this thesis focuses on the management of project risks, it will consider both threats and opportunities as risks. Hillson and Simon (2007) indicate that more and more professional standards and guidelines are currently adopting a broadened definition of risk. This has caused the trend of using PRM processes, techniques and tools for managing both opportunities and threats. From the comparative analysis of the different definitions of risk within projects, one can create a “best practice” definition of project risk that contains the following four elements:

A **project risk** is:

1. A **future event**
2. which is **uncertain** (having a certain *probability of occurrence*)
3. with a **consequence** (*positive or negative*)
4. on **project objectives**

It should be noticed that the APM PRAM guide introduced a different risk concept by distinguishing between a project “risk event” and “project risk”. Where the “risk event” entitled a specific individual risk that can be identified, assessed and managed. And “project risk” is considered to be the joint effect of all risk events and sources of uncertainty that affect the project as a whole, defined as: “*The exposure of stakeholders to the consequence of variations in outcome*”. As this term might only cause confusion, this thesis will associate “project risk” with an *individual risk event*, and uses the term “risk profile” to indicate the *total risk level of the project*.

Summarizing, it has been argued that one should deliberately separate risk from uncertainty as risk is associated with an uncertain event that, if it occurs, has an effect on objectives. This event rises from specific project characteristics and requirements that may cause risk. The “best practice” definition of risk recognizes that the effects of risks on objectives may be both positive and negative, implying that a risk is either a threat or an opportunity (Ward and Chapman, 2003). Unlike uncertainty, risk has a certain probability and impact and can therefore be quantified.

5.3 The PRM Process

Everyone agrees that for the management of risks, one will need to develop and implement appropriate responses and actions. However deciding which response is considered to be “appropriate” requires risks to be assessed on their relative significance, assuming that they first have been identified. Not surprisingly, every risk process contains three basic steps: *Risk Identification, Risk Assessment/Analysis and Risk Treatment*.

However these steps form only the start of the PRM process. Because one not only needs to develop a list of relevant risks and responses, but will also have to actually “manage” the development of these risks and the implementation responses. PRM is therefore considered to be a continuous process, because the project risks constantly change as objectives change, actions are implemented, new information is acquired and activities are completed. An explicit PRM process should therefore recognize and inhibit the four essential functions of management (Bateman and Snell, 2007):

- **Planning:** “*The management function concerned with defining goals for future organizational performance and deciding on the tasks and resource use needed to attain them.*”
- **Organizing:** “*The management function concerned with assigning tasks, grouping tasks into departments, and allocating resources to departments.*”
- **Leading:** “*The management function that involves the use of influence to motivate employees to achieve the organization’s goals.*”
- **Controlling:** “*The management function concerned with monitoring employees’ activities, keeping the organization on track toward its goals, and making corrections as needed.*”

These basic functions of management will have to be integrated with the PRM process to ensure its effectiveness in practice. Accordingly, the first step in the PRM process should not be the identification of risks, but the **planning** of the PRM process itself. It is only possible to effectively identify risks if the objectives, crucial stakeholders and scope of the process are clear in advance.

Next, the actual management of risks has to be **organized**. Organization is essential to assign resources and responsibilities to the right persons for the realization of agreed objectives. PRM therefore not only entitles the development of adequate responses, but also the organization of the actions, responsibilities and methods for their effective implementation.

To make sure the delegated tasks are performed in the right way, the PRM process has to address the issues of **leadership**. Effective communication forms an important element of all management processes. Leadership is necessary to make sure that individual tasks are clear to everyone, and people are inspired to commit to doing the actual work. Good reporting on risks, actions and objectives is therefore an important element of an effective PRM process.

Finally, each PRM process should inhibit means of **control**. Control is the final link in the functional chain of management activities. One will need to check the actual accomplishments so that interventions and changes to the process can be made on time. A frequent review of the PRM process is therefore crucial. For PRM, a distinction can be made between two levels of control. On one hand, the PRM process should control the implementation of risk treatment actions and the monitoring of risks. On the other hand, the PRM itself should be under control, to make sure the chosen approach is effective in coping with the project's overall risk profile.

Consequently, the processes of eight PRM standards are compared on the specific steps that make up the PRM process. A distinction is made among eight PRM process steps: PRM planning, risk identification, risk assessment/analysis, response planning/ risk treatment, implementation of responses, reporting/communication, control of risks/actions and control of the PRM process as a whole.

5.3.1 PRM Planning

Risk Management planning is about how to approach and plan the risk management activities for the project. The way the reviewed standards address the planning step in the overall process differs greatly. Some processes take a very broad view on the planning of PRM, including the development of a specific Risk Management Policy, while others consist of simply applying an existing risk management process to a specific project.

However, all standards address the fact that it is important to discuss the specific objectives of the project, the risk profile of the project and the required level of PRM implementation. Hillson and Simon (2007) argue that the specific characteristics of each project ask for a tailored risk management approach. Some projects may be very straight-forward, made up out of routine activities and thus only requiring a relatively simple PRM process with a minimum use of tools and techniques. While other projects are very complex, innovative and risky, expressing the need for a detailed and extensive PRM approach, involving all project stakeholders and using a variety of tools and techniques. Therefore, depending on the risk profile of the project, the planning step should determine the appropriate level of implementation of the risk process. Hence, the first step in every PRM process is about setting the right scope and objectives, and allocating roles and responsibilities for each of the tasks required to carry out the process in practice. The results of this step should then be summarized into an overall *Risk Management Plan (RMP)*, which specifies the specific elements, tools, organizational structure, planning and focus of the PRM process (see table 5).

5.3.2 Risk Identification

Risk identification involves determining which risks (both threats and opportunities) might affect the project and documenting their characteristics. For the identification of risks, a large variety of tools and techniques are applied in the different PRM standards (see table 5). An empirical study of Raz

and Michael (1999) has identified over 40 different techniques for risk identification, of which most are descriptive and qualitative rather than based on statistical analysis. The most common techniques used for risk identification are Brainstorming, Assumptions Analysis, Constraints Analysis, Checklist reviews, Past Project Reviews and Diagramming Techniques (Raz and Hillson, 2005).

table 5 Comparison of Risk Management Processes; Planning & Risk Identification

RM STANDARD	PLANNING STEP	RISK IDENTIFICATION STEP
BS 6097-3 : 2000	4.4 Managing the Process - Risk Management Policy - Organizational infrastructure	4.3 Risk identification and strategy 4.3.1 Risk model clarification
AS/NZS 4360 : 2000	4.2 Establish the context 4.2.2-4 Establish the context for RM 4.2.5. Develop risk evaluation criteria 4.2.6 Define the structure for risk analysis	4.2 Risk identification 4.2.2. What can happen 4.2.3. How and why it can happen
CIE/IEC 62198 : 2001	5 Organizational issues 5.1 Management of responsibilities 5.2-4 Resources, Communication, Documentation	6.2 Risk Identification (consider the impact of risks upon all project objectives – cost, time, quality etc).
IRM/ALARM/AIRMIC : 2002	9 Structure and Admin. of RM 9.1 Risk Management Policy 9.2-5 Define Roles & Responsibilities 9.6 Resources and Implementation	4.1 Risk Identification 4.2 Risk description
RAMP : 2002	A Process Launch A1 Organize and define RAMP strategy A2 Establish Baseline	B1 Plan and initiate risk review B2 Identify Risks
PRAM : 2004	1 Initiate - Set scope, objectives and context for RM - Define Project Aims - Fit RM process to project, organize RM	2. Identify phase - search for sources of risk and responses - classify: suitable structure for risks - characterize: simple label or description
PMBOK: 2004	11.1 Risk Management Planning - Decide on RM approach - Develop Project Management Plan - Assign roles, responsibilities, resources...	11.2 Risk Identification - Use of project document, RMP, risk categories - Brainstorm, assumption analysis, checklists - Rationalize risks
M_o_R : 2007	4.2 Identify - Context	4.3 Identify – Identify the risks

5.3.3 Risk Assessment

The assessment step of the PRM process is about prioritizing the identified risks, determining which are the most important threats and opportunities in order to enable a focused and active risk management approach. The prioritization of risks is important because it is impossible to respond to all risks at the same time and with the same level of attention (Hillson and Simon, 2007).

Accordingly, the PRM process needs to assess all identified risks in an objective and holistic manner, concerning the two key factors that together make up the risk's relative importance: Its probability of occurrence (*likelihood*) and potential impact (*consequence*) on objectives. From the analysis of the different PRM standards it can be seen that there is a distinction between *risk estimation* and *risk evaluation*:

- **Risk Estimation:** Refers to assessing the probability and impact of risk events that have been identified. Often categorized on a five-point scale, ranging from “very low”, to “very high”.
- **Risk Evaluation:** Refers to evaluating the assessed risks by comparing them with previously determined risk criteria and thresholds to prioritize the risks for effective treatment. In most cases, probability and impact scores are combined to provide an overall PI-score to prioritize the risk.

It can be concluded that most PRM standards use the same workshop for the assessment of risks as was used for the identification of risks. Because the people who identified the risks are usually the ones who can best assess their perceived probability and impact. To rule out individual biases as much as possible, risk assessment is generally considered to be a group effort. Different perspectives on the relative importance of each risk may give rise to discussions and conflicts. However such discussions are crucial to gain a common understanding among the project's key stakeholders on the project's main risks and focus points. PRM standards therefore indicate that an experienced facilitator is required for the risk assessment phase to provide assistance in overcoming group

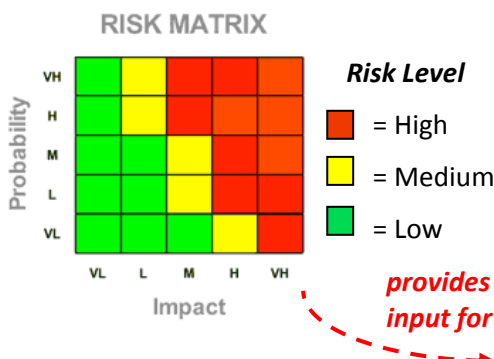
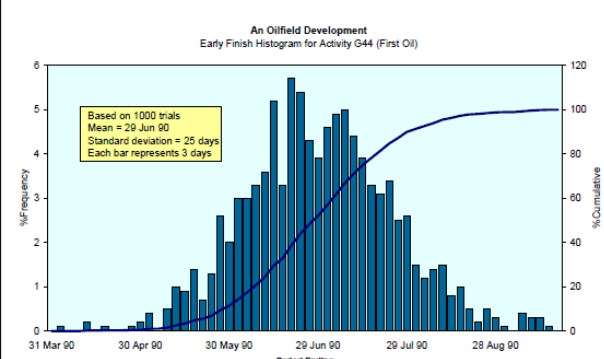
conflicts. Next, it can be seen from table 7 that there is an important distinction between qualitative and quantitative risk assessment/analysis:

- **Qualitative Risk Analysis:** Refers to the assessment of the probability and impact of risks on a qualitative scale, using established qualitative-analysis methods and tools. A risk matrix is often used to prioritize risks on their relative importance, together with a Risk Breakdown Structure (RBS) for the categorization of risks. Consequently, the assessed risks are recorded in the Risk Register, according to their relative importance. The impact of risks may be assessed separately on the project's costs, schedule, functionality, quality etc. (APM PRAM, 2004, PMI PMBoK, 2004)
- **Quantitative Risk Analysis (QRA):** Is about determining the combined effects of risks on the project's outcome, using advanced risk analysis software to simulate possible futures in the face of risk. The consequences of each risk are estimated by a specific quantitative distribution, which represents the associated uncertainty of each risk. Next, Monte Carlo simulation and decision analysis techniques are used to determine how risks will affect the project's objectives. Providing an in-depth analysis of the combined effect of project risks, to determine realistic and achievable targets and to estimate the size of cost and schedule contingencies that may be needed (Hillson and Simon, 2007).

It should be noticed that qualitative risk analysis is a prerequisite for performing quantitative risk analysis. In many cases, risks are prioritized by the use of qualitative methods. Next, the most important risks are further analyzed and assessed with the use of quantitative methods. When performed effectively, QRA will assist project management to determine the chance a project will meet its objectives. This makes it possible to identify critical project parameters and risks that affect the project the most. Quantitative analysis can support the estimation of the project's initial plans and giving a realistic implication of the overall chance these plans will be met.

Hillson (2004) gives several differences between qualitative and quantitative risk analysis that are shown in table 6. Additionally, an example is given of the qualitative risk output (Probability and Impact-matrix) and the output of a quantitative Monte Carlo simulation.

table 6 Difference between Qualitative and Quantitative Risk Analysis

QUALITATIVE RISK ANALYSIS	QUANTITATIVE RISK ANALYSIS
What is the risk?	Modeling risks & uncertainty
Why might it occur?	Simulate combined effects of risks
How likely is it? (<i>Probability</i>)	Predicting outcomes of possible futures
How bad/good might it be? (<i>Impact</i>)	Range estimates, quantitative distributions
Does it matter?	Testing scenarios
What can we do?	Setting confidence limits and realistic targets
When should we act?	Identifying criticalities
Who is responsible?	Determining options and contingencies
Record/Analyze in Risk Register & Risk Matrix	Model in Software; Monte Carlo Simulation
 <p>RISK MATRIX</p> <p>Probability</p> <p>VH H M L VL</p> <p>VL L M H VH</p> <p>Impact</p> <p>Risk Level</p> <p>Red = High Yellow = Medium Green = Low</p> <p>provides input for</p>	 <p>An Oilfield Development Early Finish Histogram for Activity G44 (First Oil)</p> <p>Based on 1000 trials Mean = 29 Jun 90 Standard deviation = 25 days Each bar represents 3 days</p> <p>%Frequency</p> <p>%Cumulative</p> <p>Period Ending</p>

Apart from assessing the risks on their relative importance, most risk standards express the need for the categorization of risks and the assessment of risk ownership (see table 7). Risk categorization allows risks to be grouped to identify common causes of risks and specific areas of the project where risks are concentrated.

The final elements of the assessment step in the PRM process is to assign risk ownership; to determine who is held responsible for the management of the identified risk. It is important to notice that one should not assign the risk to the person who identified it; neither should it by definition be the project manager. Risks should be assigned to the persons that can best manage them, concerning their power, experience and knowledge of the specific subject (Hillson and Simon, 2007).

table 7 Comparison of Risk Management Processes; Assessment & Response Planning

RM STANDARD	RISK ASSESSMENT STEP	RESPONSE PLANNING STEP
BS 6097-3 : 2000	4.3.2 Risk Analysis 4.3.3 Risk Evaluation -Threats & Opportunities	4.3.4 Risk Treatment
AS/NZS 4360 : 2000	4.4 Risk Analysis 4.4.2 Determine existing strategies 4.4.3 Consequences and probability 4.4.4 Types of analysis (qualitative or quantitative) 4.4.5 Sensitivity Analysis 4.5 Evaluate Risks	4.6 Risk treatment 4.6.2 Identifying options for treatment 4.6.3 Assessing risk treatment options 4.6.4 Preparing and implementing plans
CIE/IEC 62198 : 2001	6.3 Risk Assessment - Risk Analysis (qualitative/quantitative) - Risk Evaluation	6.4 Risk Treatment
IRM/ALARM/AIRMIC : 2002	4.3 Risk Estimation: P&I of Threats & Opportunities 4.4 Risk analysis methods and techniques 4.5 Risk profile summarizes results of analysis	7 Risk Treatment
RAMP : 2002	B3 Evaluate risks	B4 Mitigate Risk B5 Assess residual risks B6 Plan responses to residual risks
PRAM : 2004	3. Assess phase - structure, ownership, estimate, evaluate	4. Planning responses phase - Plan risk event responses - Plan project risk responses
PMBOK: 2004	11.3 Qualitative risk analysis 11.4 Quantitative risk analysis	11.5 Risk Response Planning
M_o_R : 2007	4.4 Assess – Estimate 4.5 Assess – Evaluate	4.6 Plan

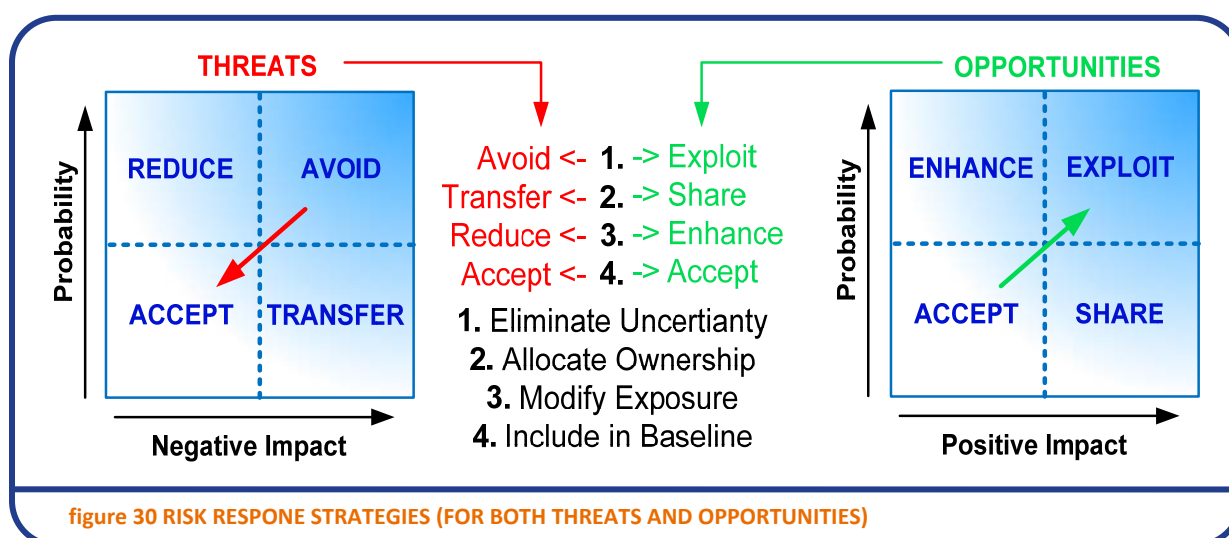
5.3.4 Risk Treatment or Response Planning

The response planning of risks considers the process of developing different options and actions to reduce threats and enhance opportunities that affect the project's objectives. The previous steps of the risk process can be seen as the initial analysis needed for determining adequate responses, scoping the project's challenge and gaining a better understanding of the project's risk profile. Now, the risk process should shift to a more action-oriented approach, focusing on actually dealing with the identified risks to increase the chance of meeting objectives.

The key to developing responses to project risks is *appropriateness* (Hillson and Simon, 2007). For some risks, it might be appropriate to change the entire project. While for others it might be appropriate to do nothing at all, and just wait to see what the future has to offer. Decisions on the treatment of risk should be made in the light of the specific *type of risk*, its *manageability*, the *impact severity*, the *availability of resources* and the associated *cost-effectiveness* (Hillson, 2004). It is often required to select the best approach from several options, ensuring that the chosen strategy is cost-effective, timely, realistic and agreed upon by all relevant project parties. From the literature analysis, four general risk response strategies have been derived (see figure 30). And as most standards adopt a broad view on project risks, these generic strategies can be applied to both threats and opportunities. In descending order of importance, these strategies include:

- **Eliminate Uncertainty (Avoid or Exploit):** For threats, elimination of the risk means *Avoidance*. Risk avoidance means that the project plan is changed so the risk no longer exists or the project objectives are protected from its impact. One might reduce the scope of the project, add resources or extra time, or change the entire approach by avoiding innovations or unfamiliar subcontractors. To avoid a risk (or terminate them) one needs to eliminate either its probability or impact. For Opportunities, the response indicates risk *Exploitation*, which focuses on ensuring that the opportunity will occur.
- **Allocate Ownership (Transfer or Share):** Transference of risks means that the risk is shifted to a third party. This might be an insurance company, the client, the government or for instance a subcontractor. However when a risk and the management thereof is the responsibility of another organizations, it does not necessarily eliminate the risk. If one is still accountable for the effects of the risk, transference implies that the new risk owner should be monitored in order to ensure appropriate actions are taken to avoid or reduce the risk. In many cases, contracts are used to transfer risks to other parties. A Lump sum (fixed-price) contract transfers risks to the contractor, while a reimbursable contract leaves more risk to the client. For an opportunity, one might choose to *share* the risk with a third party that is more capable of managing it, thereby exploiting the identified opportunity.
- **Modify Exposure (Reduce or Enhance):** Among different PRM standards, several terms are used for the reduction of risks, e.g. *reduce*, *mitigate* or *treat*. The reduction of risks means that the probability and/or consequences of the risk are minimized to an acceptable level. Early actions to reduce project threats are more effective than repairing the consequences after it has occurred. However the costs for reducing a risk should be appropriate, considering the likely impact of the risk. Designing redundancy, adopting a different concept, conducting more tests, choosing a more stable subcontractor or adding more time and resources are common mitigation strategies. For an opportunity, the exposure can be modified by *enhancement*, increasing the probability of occurrence or its potential effects on project objectives.
- **Include in baseline (Accept):** When no proactive actions are taken (because it is not worth the effort or impossible) one must *accept* (or take) the identified risks. However this does not necessarily mean doing nothing. Active acceptance means developing a contingency or fallback plan that can easily be adopted when the risk occurs. Alternatively, a contingency allowance or reserve might be included in the project's budget, schedule or contract. Passive acceptance means that no action is taken, and that it remains up to the project team to deal with the risks (or problems) as they occur.

After an appropriate response strategy is chosen, specific actions should be developed to implement that strategy. Where the general response strategy can be described in a couple of sentences, the specific actions that are associated with this strategy need to be developed and described into as much detail as possible (Hillson and Simon, 2007). Response actions must indicate what should be done, by whom, when, at what cost and to which criteria. All risk management standards recognize the need to specifically assign ownership of the planned actions to the persons that have the necessary skills and experience to ensure their effective execution (see table 7).



It can be seen from table 8 that most of the PRM standards end the phase of response planning when adequate plans and responses have been developed. Except for the PRAM (2004), RAMP (2002) and PMBOK (2004) standards, where equal attention is devoted to the risks that result from responses; e.g. *Residual Risks* and *Secondary Risks* (see figure 31):

- **Residual Risks:** Residual risks are those that remain after the specific response strategy (avoidance, transfer or mitigation) has been implemented. In case the risks are accepted by providing adequate contingencies, the risk level before and after risk response planning is considered equal. However when other strategies are implemented, the risk level should change. From the analysis of the change in perceived risk level, it is possible to provide an overview of the post-response risk level of the project and thereby show the effectiveness of the risk process.
- **Secondary Risk:** The risks that arise from the implementation of an agreed actions or response. Secondary risks should be smaller than the perceived original risks, however they can form a significant threat to the project outcome and therefore need to be assessed and treated. The same process (identify, assess and respond) is used to address secondary risks.

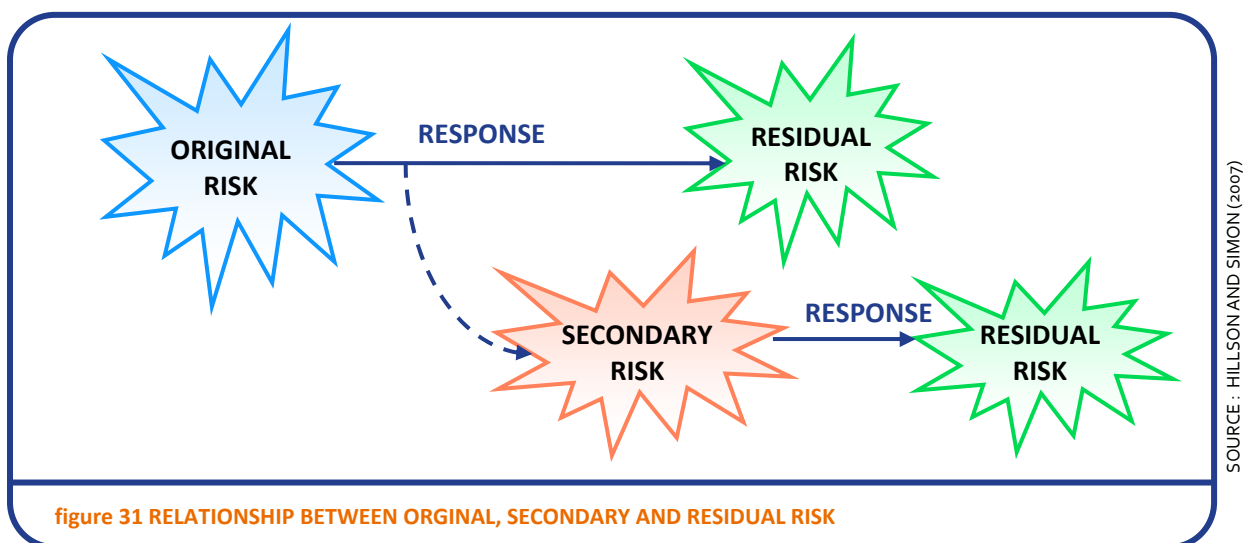


figure 31 RELATIONSHIP BETWEEN ORIGINAL, SECONDARY AND RESIDUAL RISK

5.3.5 Reporting & Communication within the PRM process

So far, there has been a great deal of correspondence among the different PRM standards regarding the specific components of the risk process. Every guide recognizes the separate steps for planning, identifying, assessing, and treating risks. However there are some important differences among the standards when it comes to the inclusion of additional elements such as good communication, frequent collaboration, extensive reporting and rigid control to ensure that the risks are actually managed continuously.

The first steps of the PRM process are all about gathering the right information and making crucial decisions on the desired approach for managing risk. However after this initial “assessment” the process should shift to the actual “management” of risks and responses that have been identified (see section 5.3). Previous steps of the PRM process discussed in this chapter don’t guarantee that people will commit to actually changing the project’s risk profile. Accordingly, the first step after the response planning is to properly communicate these plans to those who must take action. The BS609703, AS/NZS 4360, CIE/IEC 62198, RAMP and M_o_R PRM processes recognize the importance of including a specific step for communicating the results of the PRM process (see table 8). However the specific requirements for communication and reporting vary greatly between the different PRM standards. Some indicate that one should simply send all “documents” to the project’s stakeholders, while others express the development of a specific risk report.

Generally, the communication on the risk process is carried out by summarizing all the important risks, decisions, actions, responsibilities etc. in an overall risk report. Good reporting and communication means that it is clear to everyone what should be done, by whom and when. Furthermore, it is important to provide top management with the most important results of the PRM process. What are the top risks identified? What is currently done to cope with these risks? What is the perceived effectiveness of the planned responses? What is the overall risk profile of the project? How sure are we about meeting our cost and time objectives?

The PRM process has generated important information to answer each of these questions, which should be presented to the project's decision-makers in a clear and distinct manner. Consequently, it is important to provide the right information to the right people, thereby increasing the effectiveness of the entire risk process.

table 8 Comparison of Risk Management Processes; Reporting and Implementation

RM STANDARD	REPORTING	IMPLEMENTATION OF RESPONSES
BS 6097-3 : 2000	<i>Communicate</i>	<i>4.3.5 Implementation</i>
AS/NZS 4360 : 2000	<i>Communicate and Consult</i>	...
CIE/IEC 62198 : 2001
IRM/ALARM/AIRMIC : 2002	<i>Risk Reporting</i>	...
RAMP : 2002	<i>B7 Communicate strategy and plans</i>	<i>C1 Implement strategy and plans</i>
PRAM : 2004	...	<i>6 Implement Responses Phase</i> - Implement responses to risk events - Implement responses to project risk
PMBOK: 2004
M_o_R : 2007	<i>2.6 Reporting</i> <i>4.8 Communicate</i>	<i>4.6 Implement</i>

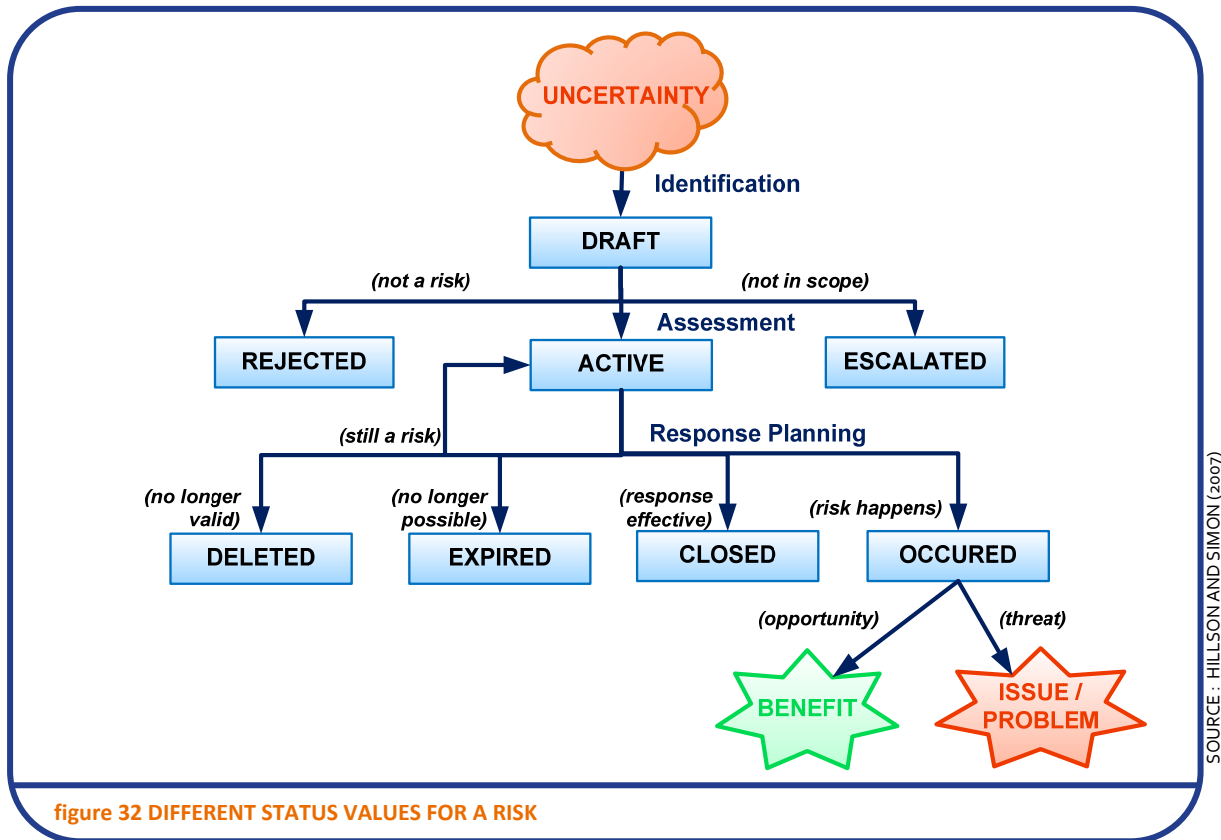
5.3.6 Implementation of responses and actions

Next, the agreed actions will have to be implemented. Failing to implement the responses and actions means that the risk status of the project will remain the same and all initial efforts have been in vain. The M_o_R, PRAM, RAMP and BS 6097 standards specifically address the implementation step in the PRM process (see table 8). This step addresses the need to continuously report and update project plans, risk registers and the status of specific responses and actions. The implementation of these actions should be carried out continuously throughout the entire project lifecycle. This implies that there is in fact no definite start or end of the implementation of risk responses. However, Hillson and Simn (2007) indicate that there needs to be a comprehensive system to check the progress and status of specific actions. Furthermore, new risks might be raised as the project proceeds, for which additional actions are required.

A lack of attention to the implementation of risk responses could easily result in failure of the project. In most cases, response actions represent additional tasks for the project's management team. And as people are generally inclined to first address their regular work, the activities for the management of risks are easily put on the long-run and might even be abandoned altogether. Consequently, the implementation of risk management activities cannot be left to chance. The project's risk register and should constantly be updated. This implies that PRM has to be fully integrated with other management systems and procedures. The M_o_R, PRAM and RAMP standards provide that for effective implementation, one should actively report on a risk's status. Hillson and Simon (2007) provide eight possible status values for a risk (see figure 32).

For the initial identification phase, *draft* risks are evaluated by all important stakeholders. When a risk is not considered to be valid, it is *rejected*. When a risk is valuable but lies outside of the project's scope, the risk is *escalated* and handed over to another person or department. The *active* risks are the ones considered valid, that might affect the project positively or negatively. When the project's

environment, scope or objectives change, some risks might not be valid anymore and can be *deleted*. *Expired* risks are those which could have happened during the project, but are currently no longer possible, because time has caught up with them. *Closed* risks have been addressed effectively by the agreed responses. Risks that have *occurred* evolve in either a problem (threat) or a benefit (opportunity) to the project's outcome.



5.3.7 Monitoring and Control

For every management process, extensive monitoring and control is necessary to ensure its effectiveness. At the beginning of the project, people are usually enthusiastic about managing project risks and actively participate in the PRM process. However it is important that this momentum is maintained throughout the entire project lifecycle. To do so, one needs to review and monitor the management of risks as the project proceeds. All PRM standards therefore explicitly address the issues of controlling the risk management process by constantly monitoring its results and including new information or adequate changes to the chosen approach (see table 9).

A distinction can be made between different levels of review within the PRM process. One might check the status of the identified risks and actions, or review the entire risk level of the project by repeating all the previous process steps. Moreover it is possible to review the PRM process on its effectiveness in coping with the specific risk profile of the project. Hillson and Simon (2007) distinguish among three levels of review throughout the project's lifecycle:

- **Minor Reviews:** Updates carried out on a regular basis, where the latest information on the risks is discussed and RM documents are updated. Minor reviews consist of checking the most important risks and actions in a meeting with all the important project stakeholders. It functions as an update of the current process, to include new insights or risks, and change actions when necessary. These review sessions should be part of the conventional management cycle, carried out on fixed intervals

- **Major Reviews:** Major reviews are carried out at key points during the progress of a project, either at the beginning of a new project phase or at a significant milestone. At these moments, the project usually experiences a huge change in the perceived risk profile, so it is desired to review all the project's risk documents. According to Hillson and Simon (2007), a major review should take place in an explicit workshop with all project stakeholders, repeating the previous steps of the PRM process. In many cases, the PRM process itself is reviewed as well, so necessary changes can be made to improve its effectiveness. Changes to the chosen approach, risk levels and response strategies are developed and included in a new risk report.
- **Post-Project Review:** An important aspect of every project is to contribute to the learning of the entire organization. Project-based organizations need to create a body of knowledge and experience from every project. This can be used to increase performance on future projects. Therefore it is important to review the PRM process when the project is completed. This review session therefore focuses on identifying the relevant lessons learned from the RMP process, and documents risks that have occurred and the effectiveness of the actions that have been implemented. This provides an important starting point for the improvement of risk management effectiveness in future projects.

table 9 Comparison of Risk Management Processes; Control of Risks/Actions and RM Process

RM STANDARD	REVIEW OF RISKS/ACTIONS	REVIEW OF RM PROCESS
BS 6097-3 : 2000	4.3.5 Implementation - Monitoring of resources usage - Monitoring of agreed risk indicators - Monitoring of risks	4.4 Managing the Process - Monitoring and reviewing RM
AS/NZS 4360 : 2000	1.7 Monitoring and Review - Effectiveness of treatment measures - Review estimates - Actual progress against plan	2.3.10 Monitor and Review 2.4 Management Review
CIE/IEC 62198 : 2001	6.5 Risk review and Monitoring	6.5.2 Post-project Review - effectiveness of RM process
IRM/ALARM/AIRMIC : 2002	8. Monitoring and review of RM	...
RAMP : 2002	C2 Control Risks	D2 Review RAMP process
PRAM : 2004	5. Implement Responses Phase - Monitor changes in risk exposure - Address RM process effectiveness	6. Manage process - Review approach for each phase
PMBOK: 2004	11.6 Risk monitoring and control	...
M_o_R : 2007	5. Embed and review Management of Risk	2.13 Continual Improvement

5.4 “Best Practice” PRM process: The ATOM Methodology

From the analysis set out in this chapter, it can be concluded that “best practice PRM” goes beyond the identification, assessment and treatment of risks by explicitly addressing the steps to continuously manage risk in practice. In order to do so, the following elements should be included in a “best practice” PRM process, which result from the literature review set out in this chapter:

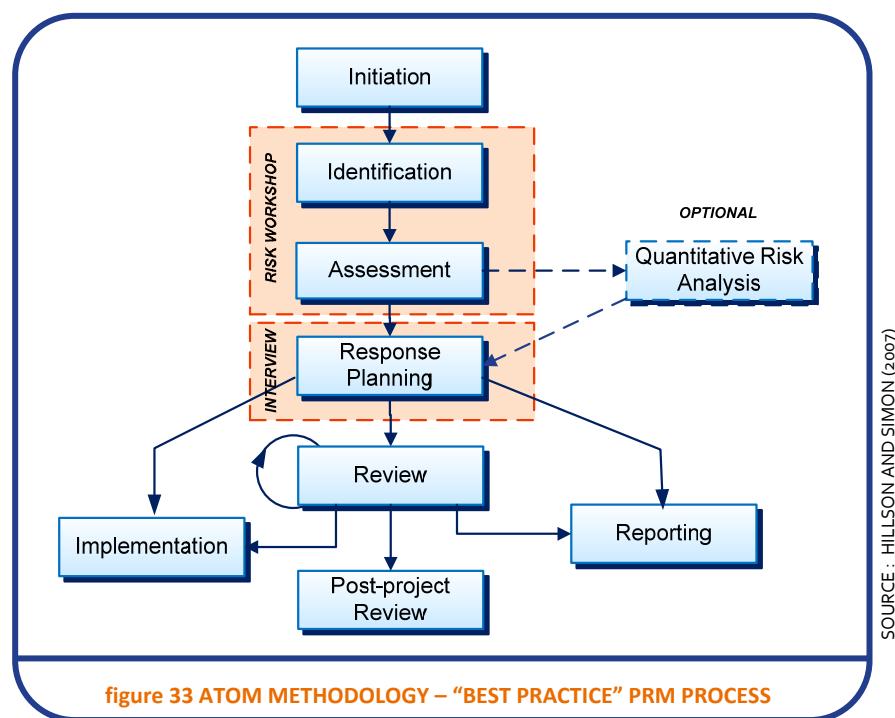
- Include the management of **both threats and opportunities** in a single process (section 5.2.2).
- **Clearly defining** the scope, focus, objectives, roles, responsibilities and **required level of risk management implementation** for each particular project **in advance** (section 5.3.1).
- Identify, prioritize, and plan responses **to both threats and opportunities** (section 5.3.2, 5.3.3, 5.3.4).
- Explicitly address the **necessary means to move from planning to action** so that the responses to risk are actually implemented and monitored to achieve the desired effect (section 5.3.6).
- Keeping all important stakeholders informed of the risks, their importance and the planned actions by **effective communication and reporting** on the PRM process's results (section 5.3.5).
- Addressing project dynamics by **continuously reviewing** the risks, response actions and the entire PRM process **throughout the entire project lifecycle** (section 5.3.7).
- Ensuring that important lessons learned and experiences of managing risk are discussed, reviewed and captured to **improve risk management efforts** for future projects (section 5.3.8).

In the view of the researcher, the approach that best suits the description of “best practice” in the field of PRM is the “Active Threat and Opportunity Management” or ATOM-methodology developed by Hillson and Simon (2007). The ATOM process is designed to meet the need for a simple PRM process that can be applied to all projects. ATOM is developed to manage both threats and opportunities in a single process, bringing together “*recognized best practices and tried-and-tested methods, tools and techniques*” in the field of PRM.

The ATOM methodology is fully consistent with current PRM standards that have been reviewed in this chapter, and explicitly addresses the necessary elements of planning, organizing, reporting and controlling the management of risk in practice. Furthermore, the ATOM PRM process is the most recently published practical handbook, based on findings from over 40 years of experience in the field of PRM. In essence, the ATOM process combines current “*best practice guidelines and standards into a comprehensive, proven, practical methodology for managing project risk, presented as a simple stepwise process*” (Hillson and Simon, 2007).

Therefore this thesis will use the ATOM PRM methodology as a framework for the analysis of risk management at HMC. Comparing the ATOM process with the current process implemented at HMC will make it possible to explore differences and similarities, thereby creating a better understanding on how the effectiveness of HMC’s approach might be improved to better manage risk in EPRD projects. The specific steps and elements of the ATOM process provide the means for structuring the analysis in the following chapters. The ATOM process is composed of the following eight steps that clearly reflect the subsequent elements of PRM theory that have been discussed in this chapter (see figure 33):

1. **Initiation:** The initiation step considers the project’s stakeholders and their relationships. Aiming to confirm and clarify the project’s objectives so that the uncertainties that really matter (risks) can be identified and prioritized in an effective manner. The size, complexity and risk profile of the project are discussed in an initiation meeting to determine the scope and required level of RM implementation.
2. **Identification:** A formal two-day risk workshop is used to identify and assess project risks, as well as their probability and impacts. Aiming to identify and properly describe all risks, including both threats and opportunities. To do so, risks should be separated from their causes (uncertainty) and effects.
3. **Assessment:** The Assessment of risks is carried out on the second day of the workshop, using predefined scales to prioritize risks by their relative probability and impact. Risks are categorized using the RBS and WBS of the project, and each risk is assigned to a specific risk owner. The results of this step are recorded in the project’s Risk Register. Quantitative risk analysis techniques are optional, depending on the specific risk profile of the project which is decided upon in the initiation step.
4. **Response Planning:** After the initial risk workshop, risk response planning takes place by a series of interviews with the identified risk owners. Adequate responses are identified, together with their associated actions and action owners. The appropriateness of the selected response is considered, and the residual and secondary risks are assessed.
5. **Reporting:** The results of the First “Risk Assessment” are documented in a full risk report, which is distributed to all important stakeholders, risk owners and action owners. Good reporting ensures that the dynamic nature of risk management is effectively communicated to all project parties.
6. **Implementation:** At the same time as the Reporting step, the continuous Implementation of responses via their associated actions starts. Implementation of responses continues throughout the entire project lifecycle, making sure that the initial plans are transformed into effective actions.
7. **Review:** To keep the process alive, formal risk reviews take place throughout the project life cycle. Regular review meetings take place as part of the normal project reporting cycle. Updating the project’s risk register and checking progress on the agreed actions and responses. At predetermined points in the life cycle of the project, a major review of the risk register takes place in a separate workshop. New risks are identified; assessed and agreed responses are updated and implemented.
8. **Post-project Review:** The ATOM process concludes with a formal Post-Project Review meeting, where the “risk lessons learned” are discussed and reported. Providing important input for future projects.



5.5 Summary and conclusions

In section 5.1.3, it has been argued that “Best practice” PRM is considered with the definition of “Project Risk” and the specific components that make up the “Risk Management Process”.

From the comparative analysis among eight different PRM standards, it can be concluded that a project risk should be defined as: **“An uncertain event that if it occurs, would have a positive or negative effect on the achievement of one or more project objectives”**. Thus current best practice within the field of PRM adopts a broad view on risk that includes both the *positive* or *negative* effects of uncertainty. Consequently, risk can form both a treat and an opportunity to the project’s result. Furthermore, risk should be seen separate from uncertainty, because a risk has a certain probability and impact that makes it possible to quantify the risk. Risks are future events that stem from uncertainty and have the potential to influence an objective (*risks = uncertainty that matters*); hence risks rise from the interactions between uncertainty and objectives. This makes it possible to quantify and measure a risk in terms of its **“probability”** (chance of occurrence) and **“impact”** (effect on objectives). Each project risk has a certain probability between 0% and 100%, and a perceived impact or effect on one or more specific project goals. Accordingly, the actual risk event should be separated from its cause (uncertainty) and effect (impact) on project objectives.

From the analysis of the different components that make up the generic PRM process, it can be concluded that there is great resemblance among the eight standards that have been examined in this chapter. Each PRM process that has been reviewed recognizes the need to plan, identify, assess, treat and monitor risks throughout the project lifecycle. Variations on the contents of the specific steps stem for a large part from differences in terminology and the specific techniques that ought to be used. But in general, the principles and guidelines are identical for all PRM processes and standards. In principle, there is a common methodology for managing project risks as the general process is well defined, proven techniques exist and there are various tools to develop PRM knowledge and skills.

However there are also some important differences between the PRM standards that arise from the additional effort that is needed to actually “*manage the risks*” in proactively and continuously. The processes that have been reviewed differ significantly on the inclusion of elements that ensure that the process is adequately controlled, reviewed, communicated and reported upon. Certain standards only cover the PRM process itself, and ignore the organizational infrastructure that is necessary for its effective application. Other elements that are lacking in most standards are the attention to measuring the effectiveness of risk responses, risk treatment actions and the process as a whole. It can be concluded that “best practice” implies that the PRM process itself should include explicit steps to ensure that it remains under control, promoting a continuous review and improvement of the PRM approach and response plans (see table 10).

table 10 Summary of PRM processes identified from literature

PROCESS GUIDE		A	B	C		D	E	F	G	H
				C1	C2					
NATIONAL STANDARDS	BS 6097-3 : 2000									
	AS/NZS 4360 : 2000									
	CIE/IEC 62198 : 2001									
	M_o_R : 2007									
PROFESS. STANDARDS	IRM/ALARM/AIRMIC : 2002									
	RAMP : 2002									
	PRAM : 2004									
	PMBOK: 2004									
PRM HANDBOOKS	Cooper et al. : 2005									
	ATOM : 2007									
	Chapman & Ward : 2004									
	Loosemore : 2006									
	Kliem & Ludin : 1997									
PM LITERATURE	Kerzner: 2003									
	Nicholas : 2004									
	Buttrick : 2005									
	Dinsmore et al. : 2004									
	Meredith & Mantel: 2006									

Columns:

A = Planning

B = Identification

C = Assessment

C1 = Qualitative

C2 = Quantitative

D = Response Planning

E = Reporting

F = Implementation

G = Minor/Major Review

H = Post-Project Review

Row Categories:

- (Inter)national Standards
- Professional Standards
- PRM Handbooks and Guides
- PM literature and Handbooks

Apart from the differences in how each risk management standard addresses the organizational infrastructure needed for the effective management of risk, it is interesting to see that the elaboration on the subject of risk management within Project Management literature is rather limited (see table 10). Most Project Management handbooks include a separate chapter on the subject of risk, but the management thereof is in most cases considered as “*just another project management technique*” (Hillson and Simon, 2007).

Consequently, its application is in many cases not fully integrated with the overall project management process, but considered as optional and additional. Moreover, the Project Management handbooks that have been reviewed merely contain the theoretical principles of managing risk, e.g. the methods and techniques for risk identification, assessment and treatment. However the means to effectively implement, organize, monitor and control the actual management of risks in practice are often neglected in common PM handbooks.

Despite the many international and professional PRM standards, there is no single global standards for the management of project risk that is widely applied. This notion is supported by various PRM practitioners and recent empirical studies on the subject of PRM (Hillson, 2004; Baker et al., 1999; Arrow, 2008). From the analysis set out in this chapter, it can be concluded that the ATOM methodology of Hillson and Simon (2007) fits the prescription of “best practice” in the field of PRM. The methodology, processes, tools and techniques described in the ATOM process will therefore form the basis for further the research carried out in the following chapter of this thesis.

Chapter

6

*"There are risks and costs
to a program of action.
But they are far less than the long-range
Risks and costs of comfortable inaction"*

John F. Kennedy

"Chance only favors the prepared mind"

Louis Pasteur

*"Experience is a clear teacher,
and only fools will learn from no other"*

Benjamin Franklin

6.1 Method Used for Analysis

6.2 PRM Initiation

6.3 The Risk Workshop

6.4 Quantitative Risk Analysis

6.5 From plan to action

6.6 Risk Review and Evaluation

6.7 Summary and conclusions

6. HMC Risk Management



HMC's excellent reputation as a marine heavy lifter stems from the company's ability to constantly respond to changing industry's needs, the dynamics of the offshore market and the vast array of challenges considered with every project HMC takes on. Not surprisingly, risk management is something deeply imbedded in HMC's organizational culture and management systems.

However up until 2003, there has not been a formalized or companywide approach for the management of project risks within HMC. Project risks and their management have always been the full responsibility of the project's manager, like the risks within a tender have always been managed by the respective tender manager. Currently, the designated project/tender manager is still the one person responsible for the risks within a HMC project or tender. However during the past six years HMC has developed and implemented a formalized *procedure* for the management of project risks.

The origins of this procedure lay within the QESH department, where the first PRM process was developed in 2003. It was argued that HMC needed to ramp up its risk management efforts because the company aimed at broadening its project portfolio from installations towards deepwater pipe lay projects. The initial procedure was further broadened and standardized in 2006, when the implementation and facilitation of PRM came under the responsibility of the Legal Department. It was assumed that the legal department could ensure independence, as they are not directly affected by specific goals or personal games within a project's organization that might influence the management of risks. Accordingly, two risk co-coordinators were assigned to support all risk management activities and maintain a companywide PRM standard. An important benefit of the centralized facilitation of PRM was the opportunity to gather risks from each and every project that HMC performed simultaneously and then roll these up to an overall "*company risk profile*" (interviews 1, 5 & 16, see appendix N).

It can be concluded that formal risk management has only recently been developed and implemented at HMC, compared to the company's long history of successfully executing record-breaking projects. Accordingly, there is still little known of the effectiveness and added value of the current PRM procedure in practice. Does the current process effectively support the management of risks in HMC's projects? And how do HMC's risk workshops, quantitative risk models and risk registers ensure that the relevant project risks are actually managed proactively? These questions are of particular interest to HMC in the context of the large and complex EPRD projects within their current project portfolio. As set out in chapter 2 and 4, these projects are of significant importance to the continuance of HMC as a company, and they are subjected to many technical, organizational, commercial and environmental risks. Hence, the focus of this chapter is to analyze HMC's PRM

process in the light of “best practice” PRM process set out in chapter 5. Carefully mapping and comparing HMC’s PRM process with the ATOM methodology (see chapter 5) allows to identify similarities and differences between current and best practice PRM. The gaps between theory and practice provide an important starting point for the development of improvements to HMC’s approach to better cope with the risk profile of complex EPRD projects. The analysis set out in this chapter focuses on two aspects of HMC’s PRM, e.g. the *risk management process* and its *application within EPRD projects*. The research questions that will be answered in this chapter are:

3.2 What does the current HMC process for project risk management look like?

3.3 How is the process for project risk management applied in current EPRD projects?

To answer these research questions, findings from an extensive multi-case study analysis of HMC’s PRM process are discussed. The design of the case study, the methods and techniques used for the collection of data and the findings concerning the management of project risks at HMC are described in detail in appendix M. This appendix holds detailed information on the HMC’s PRM process in relation to the ATOM methodology of Hillson and Simon (2007). The differences between theory and practice are highlighted with the use of process maps, supported by quantitative data from the NWH and Ekofisk EPRD projects. The most important conclusions and considerations that resulted from the case study analysis are described in this chapter.

6.1 Method used for analysis – Multiple Case Study Analysis

To gain a better understanding of the current PRM approach HMC applies in EPRD projects, a second case study analysis is performed within this thesis. Case study analysis fits the interpretive research paradigm which has been chosen for the exploration of the problem situation in chapter 3. In the context of the heightened risk profile of current EPRD projects described in chapter 4, the findings from the literature review of chapter 5 will be contrasted with results from the case study analysis described in appendix M.

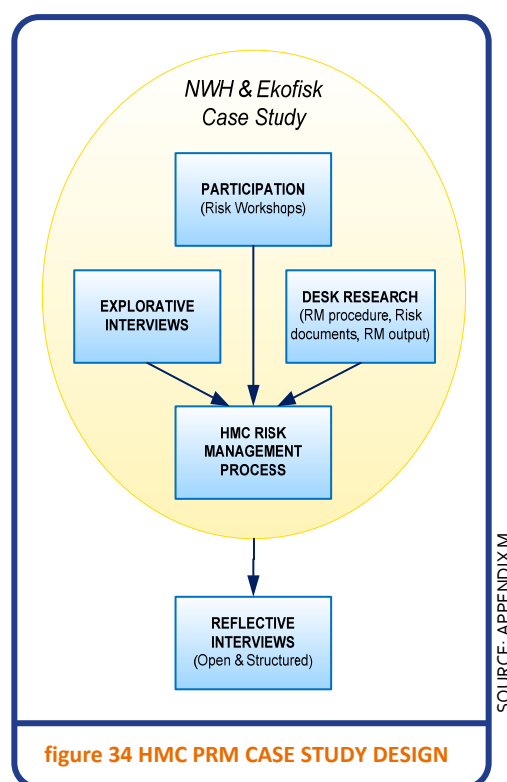
Appendix M contains a detailed description of the chosen research instruments that have been used for the collection of information to support the case study analysis. For the design of the case study, the case study protocol by Yin (2003) is used as a valuable guideline and starting point for the collection and interpretation of case information. The aim of the case study is to carefully map and analyze HMC’s PRM process. However, there is an important difference between describing the common “*risk management procedure*” and analyzing the specific activities that contributed to the “*management of risk*” in practice. It might be the case that in reality, the risk management process is not followed in correspondence with the predefined procedure. While on the other hand, there is a possibility that extra steps are undertaken to manage risk that are not considered part of the “*risk management process*”. Consequently, it is very difficult to gain a holistic understanding of the actual “*risk management process*” implemented at HMC, as risk and the management thereof are both highly contextual concepts. Case study research is considered to provide a strong method to induce a more holistic understanding of HMC’s PRM process and its application in practice. To overcome the issue of what is or is not considered to be “*risk management*”, the literature review described in chapter 5 functions as a guiding framework and starting point for the analysis. This implies that not only the Identification, Assessment and Treatment of risks is being considered, but also the essential elements of planning, reporting, reviewing and monitoring of PRM activities.

For the collection and interpretation of information, a dual perspective is adopted. On one hand, a top-down perspective (deductive reasoning) is applied to map and structure HMC’s PRM process. The ATOM methodology is used as a point of departure to identify similarities and differences between HMC’s approach and has been defined in chapter 5 as the current “best practice” in the field of PRM. On the other hand, a bottom-up perspective (inductive reasoning) is applied to identify problems, issues and considerations that affect the current process implemented at HMC. Combining

these two perspectives creates a thorough understanding of which differences and similarities are crucial for the effectiveness of managing risk in complex EPRD projects. The aim is therefore to focus on the essential elements that ensure PRM is effective in a practical situation, which increases the opportunity to make a significant contribution to its improvement.

Within the case study, multiple sources of data are used to create a rich picture of HMC's PRM process. Triangulating and comparing findings from different sources makes it possible to rule out subjective bias as much as possible. To minimize project specific bias, two cases are considered for analysis, e.g. the NWH (2008/2009) and the Ekofisk EPRD project (2009/2014). To support findings from case interviews (see appendix N), detailed information is gathered from risk documents of the NWH topsides campaign (April 2006 – October 2008). Summarizing, there are three data collection instruments used that together support the case study's findings (see figure 34):

1. **Desk research:** Comparing and analyzing HMC's management documents. The "*HMC Risk Management Procedure*" provides an important starting point, clearly describing the HMC risk process, definitions, responsibilities and reporting requirements. In addition, project specific management plans, procedures and risk documents have been studied to gain understanding of how this procedure is integrated with HMC's management system. Risk registers, quantitative risk analysis outputs and risk workshop sheets have been examined in detail to evaluate the output of the process during the NWH topsides removal project.
2. **Interviews (explorative and reflective):** 11 explorative and 9 reflective interviews have been held with key personnel from HMC's organization. This creates understanding of how the process supports the management of risk in practice. Problems, issues and considerations for improvement are discussed with the persons that are held responsible for managing the risks in current EPRD projects. Semi-structured reflective interviews have been held with HMC management to confirm preliminary conclusions and to further clarify on conflicting findings and perspectives. Furthermore, reflective interviews have been used to validate the findings from the case study.



3. **Active Participation:** In addition to the data collected by interviewing experts, participative research is used to gain a better understanding of the application of the risk management process in practice. Actively participating in the risk management process offers the unique possibility to capture the reality in greater detail. Therefore the researcher participated in a risk workshop to directly observe the difficulties of identifying, assessing and treating risks in EPRD projects.

The ATOM methodology described in chapter 5 is used as a guiding framework for the case study analysis. Process maps provide a visual overview of the differences between the HMC risk process and what is considered to be a "best practice". In appendix M, the results of the case study are described into detail for each successive step within the risk process (e.g. initiation, identification, assessment, quantitative analysis, response planning, reporting, implementation, review and post-project review – see table 11 and figure 35). This chapter will summarize the most important findings and conclusions from the case study analysis and put these in the perspective of the risks HMC faces in complex EPRD projects (chapter 4). The following elements are discussed (see figure 35):

1. **Risk Initiation:** A scalable risk management approach, fit to the project's risk profile
2. **Risk Identification and Assessment:** Effectiveness of the Risk Workshop
3. **Quantitative Risk Analysis:** The use of software tools to support decision-making
4. **Response Planning, Implementation and Reporting:** From analysis to proactive action
5. **Risk Review and Post-project Review:** The project lifecycle approach to risk management

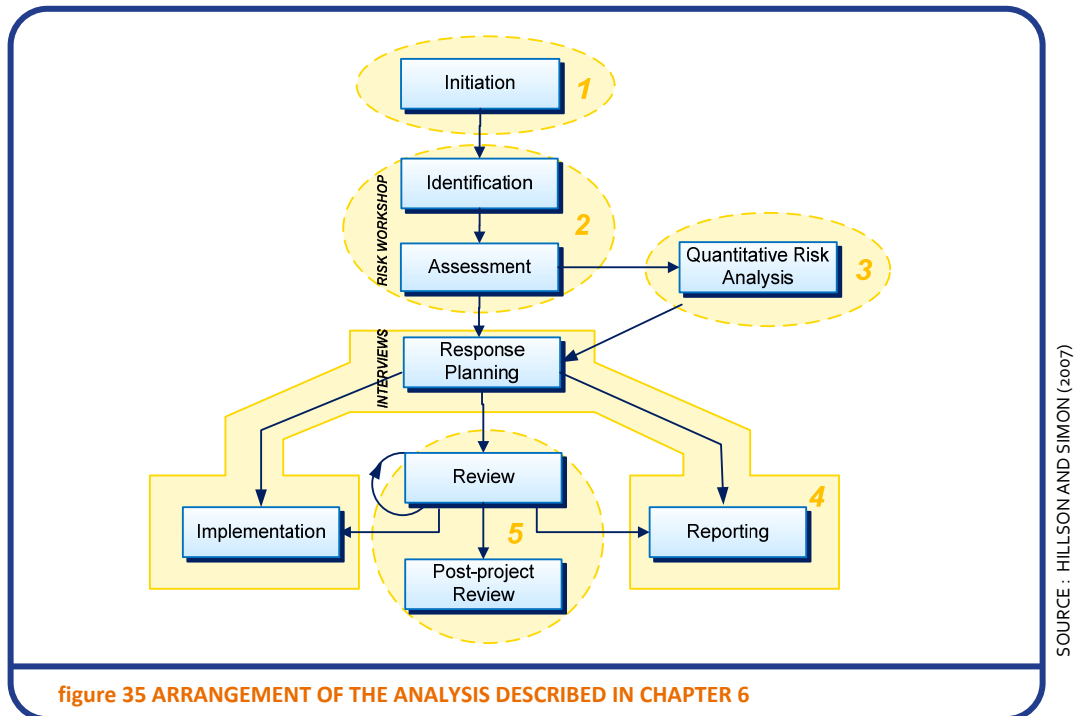


table 11 Overview of the ATOM PRM Process, source: Hillson and Simon (2007)

ATOM STEPS		INPUTS	ACTIVITIES	OUTPUTS
1	Initiation	Project size / risk profile Project Objectives Stakeholder list	Stakeholder Analysis Scope of RM process Tools and techniques Roles & Responsibilities PI Scales and RBS	Risk Management Plan RBS, Specific PI Scales RM Organization RM planning RM resources
	Identification	Risk Management Plan RBS and WBS Assumptions/Constraints Risk Checklist	Confirm scope + Briefing Brainstorm + Identify Assumptions Analysis Describe & Rationalize	List of risks Initial Responses
2	Qualitative Assessment	Specific PI Scales RBS and WBS Risk Matrix	Assess P&I Categorize risks Nominate Risk Owners	Prioritized Risk Register Double PI matrix RBS/WBS Categorization
	Quantitative Assessment	Project Schedule and CBS Risk Register Risk Responses	Develop Model Gather Risk data Pre/Post Analysis	Final Risk Analysis Output Risk Analysis Report
4	Response Planning	Generic responses Risk Register	Select Response Strategy Develop Actions Nominate Action owners Consider 2 nd Risks	Project Plan updates Post-response PI matrix Updates Risk Register
	Reporting	Risk Register (+responses) Double PI matrices Risk Categorizations	Produce Risk Report	Risk report Risk report Extracts
	Implementation	Risk Register Project Plan Updates	Implement Actions	Updated project plan Updated Risk Register
5	Review	Project Status Risk Register RBS, WBS	Review Risks Review Risk Process Review Response Actions	Updated RMP Updated Risk Register Full Risk Report
	Post-project Review	Change/Issue log Risk report Project Schedule/Cost Risk Checklist, Register	Risk Lessons Report Update Checklists Final Risk Register	Risk database Risk Lessons Learned Risk Section in PPR Report Updated RBS & checklist

6.2 PRM Initiation – One size does not fit all...

One of the most important aspects of “best practice” PRM is that the used procedure, tools, techniques and approach should be fitted to the specific risk challenge of the project. No two projects are the same; hence there is no common procedure that can be applied effectively to all projects. Each PRM process should start with determining the required level of implementation that results from the specific characteristics of the project. However many organizations tend to apply exactly the same process to all of their projects, whatever the size, complexity or perceived level of innovation (Murray Webster & Simon, 2007).

This means that in some cases an organization uses a time-consuming and perceived bureaucratic PRM process to a simple and regularly performed project, while in other cases a total inadequate “quick-and-dirty” process is applied to the most critical, complex and innovative projects. Thus, Hillson and Simon (2007) argue that what is needed for risk management to be effective is a scalable process that can be tailored to the needs and characteristics of every project. The ATOM methodology set out in chapter 5 therefore explicitly focuses on varying the tools, techniques, reviews, requirements and responsibilities of the PRM process among three levels (small, medium and large). The ATOM risk process includes a specific “initiation step” to determine the required project size, risk level and required approach. Varying the level of PRM implementation ensures that the process itself remains “*exciting*”, rather than being perceived as time-consuming, ineffective or more pointedly “*boring*”.

The notion of a scalable PRM approach is further strengthened by findings from empirical research by Raz et al. (2002). In this empirical study of over 100 projects within a variety of industries, findings suggest that there exists a strong correlation with applying PRM practices in high risk projects, while there is a relative small correlation (or even a slightly negative one) between PRM practices and the group of projects that experienced low levels of uncertainty. This might suggest that when one devotes too much time and effort to risk management in low uncertainty projects it may detract attention and energy from achieving objectives. Raz (2002) gives that using a vast array of risk management tools in simple projects “*may instill an unnecessarily conservative attitude among the project’s staff*”. While in high risk projects, there is a significant positive correlation between the efforts spent on PRM and the achievement of project objectives. Nonetheless, PRM should not be limited to high-risk projects, as the benefits of RM practices apply to all projects.

6.2.1 Project Sizing - PRM Scalability

From the case study analysis, it can be concluded that HMC uses the same risk management procedure for all of their tenders and projects (*HMC Risk Management Procedure*). This procedure contains little variation in the applied tools, techniques and methods that are used for the management of project risk (see appendix M.3.1).

Still, it should be noted that there is some differentiation *within* the HMC risk process concerning the assessment of risk. This is determined by the risk coordinator (facilitator of the risk process) using the project’s revenue and the existence of “special risk”, e.g. new technologies, partner risk, customer risk or country risk. Along these axes, the risk coordinator categorizes the required risk management assessment as being *Simple, Standard or Extensive* (interview 1, see appendix N). The difference between these three levels can be found in the organization of the risk workshop. Compared to a simple risk workshop an extensive risk workshop takes three hours instead of one, and is attended by additional specialists. But apart from this instance, there are no clear criteria to determine the appropriate level of PRM implementation at HMC. Moreover, there is no explicit step in the risk process to make sure that the entire approach is specifically designed to match the project’s risk profile. Hence, it may be concluded that risk initiation at HMC is for the greater part done in an implicit matter without consultation of the project’s stakeholders, manager and sponsor.

The importance of this difference between HMC's process and the ATOM risk process is supported by previous findings of this thesis. From the analysis set out in chapter four, it can be concluded that there is a significant difference in the level of risk associated with conventional platform installation projects and the current EPRD projects from the perspective of HMC. For most of the installations, HMC can apply their widespread experience, reputation and high quality standards to adopt a risk taking attitude and just-in-time way of working (interview 13, see appendix N). However due to the complexity, innovativeness and inexperience with large EPRD projects, a different PRM approach is required. During the case study review, many project managers indicated problems associated with the effectiveness of the current risk process in the same line of reasoning (interview 2, 8, 11, 14, & 16, see appendix N). For many conventional installation projects, the risk procedure is perceived as being time-consuming because each workshop identifies the same risks, which the management can easily address and estimate by using their widespread experience. The quantitative analysis applied in these projects is rarely used to support decision-making (interview 6, 10, 12, 13, see appendix N). While for complex EPRD projects, the risk procedure was not perceived as being appropriate and effective in identifying and managing its risks (interview 2, see appendix N). In these projects, quantitative analysis might provide a strong and effective tool for assessing the project's total risk profile. Especially in "first of a kind" projects, respondents indicate that HMC repeatedly failed to identify and manage its project risks (Interview 10, 16 & 20, see appendix N).

Best practice PRM prescribes to explicitly vary the tools, techniques, scales and review requirements that make up the RM process (see appendix M.3.1). So that for instance for simple projects the project manager quickly steps through the procedure, while for innovative and complex project "every trick in the book" is used to ensure a rigorous application of both qualitative and quantitative PRM techniques. Hence, variations should not be limited to the risk workshop, but must be extended to other parts of the process such as PI scales, the appointment of a full-time or part-time risk manager or the periodicity and intensity of updates and reviews along the project lifecycle.

The current process of HMC does not vary its approach in amount of reviews, reporting requirements, or by changing the specific tools, scales and techniques that are used (see figure 20 in appendix M.3.1). For every tender and project, both qualitative and quantitative risk assessment are mandatory, to which the same risk analysis model is applied. There is no explicit planning of PRM activities along the project's lifecycle, to identify and agree on the significant amount of risk review workshops required for long-term projects. It is interesting to see that for all other elements that are part of HMC's PM system there are project-specific plans. Every project has a dedicated Execution, Operational, Administration, Interface, Quality, Health, Safety, Data, Document and Cost Control Plan (see table 17 in appendix M.3.1). However, there is no project-specific *Risk Management Plan*. The only reference to the management of risk in project management documentation is made in the overall Project Execution Manual, where a small section gives an overview of HMC's standard PRM procedure. It might be concluded that there is only little scalability to HMC's current approach for managing project risk.

6.2.2 Stakeholder analysis –The influence of risks in partnering

Apart from explicitly sizing the project on its perceived level of uncertainty to determine the required level of PRM implementation, an important element of the initiation step is to perform a stakeholder analysis. Each project is affected by multiple internal and external stakeholders that are responsible for making important decisions about how the project should be managed. For effective risk management, these people/parties should be identified and assessed on their respective attitude, power and interest towards the project's outcome. This creates an overview of who should be included in the PRM process.

At HMC, the risk management process mainly focuses on internal project stakeholders, e.g. the project manager and members of the project team. However, as can be seen from the analysis set out in chapter 4, HMC has taken on a different role in EPRD projects. HMC is no longer the project's

subcontractor for offshore lifting and transport operations, but is held responsible for the entire chain of operations as the project's main contractor. Accordingly, HMC should not only manage its own risks but also takes on the responsibility of the risks of their subcontractors. From analyzing the NWH and Ekofisk EPRD project, it can be concluded that approximately 25% of the project's risks stem from work performed by subcontractors (see figure 27 in appendix M.3.3). Murray-Webster and Simon (2007) indicate that in many cases companies assume that their subcontractors are equally honest, educated and suitable for managing the project's risk as they are. Hence, passing the responsibility for a part of the project to a subcontractor seems attractive, but in fact one is trying to shift a part of the project's risk to another party. As Hillson (2007) states, the danger of such an approach is that you *"throw the baby out with the bath water"* because if they fail, then eventually you will fail as well. Best practice PRM prescribes to make sure that all the critical subcontractors are included in the project's risk process. This will create a mutual understanding of the perceived risks in the project and commitment to proactively addressing and managing these risks. From the analysis of the NWH removal project, it can be concluded that many project risks that fell under the responsibility of HMC's subcontractors were inadequately managed and significantly affected the project's outcome (Interview 2, see appendix N). Currently, a specialized department is developed to coordinate all project subcontractors and ensure effective communication. But there are no implications that this department or HMC's subcontractors will be actively involved in the project's risk management process, to enhance transparency and openness of project risks between HMC and its subcontractors.

Another important aspect of a stakeholder analysis is to create understanding of the conflicting interests, goals and attitudes towards the project's objectives among all project parties. From the analysis set out in chapter 4, it can be seen that there is a change in the client's perspective that influences the risk balance between client and contractor in large removal projects (see section 4.3). For the client's perspectives, it is no longer important that the platform is installed on time (driven by the first oil deadline) but that the entire operation is performed to the highest safety level for the lowest cost. During the NWH projects, there were a lot of changes to the project's scope and methods that resulted from specific client demands and safety-regulations (see appendix L). Initially, these changes were seen as being favorable to HMC, offering extra work and supposedly extra income (as is the case with most offshore installations). However as the removal contract clearly specified that the entire project scope fell under the full responsibility of HMC, most delays and extra costs that resulted from the increase in scope shouldn't be seen as opportunities, but must be considered as threats to HMC's objectives (interview 2, see appendix N). Consequently, the conflictive perspectives between HMC and its client in removal projects provides important implications for the attitude HMC should adopt towards risks in their contract, bid and schedule development. A thorough understanding of project relations and their effects on project objectives requires an explicit stakeholder analysis which is currently lacking in HMC's PRM process (see appendix M.3.1).

6.2.3 Risk Initiation Meeting – Creating clarity, transparency and a "risk-mature" attitude

According to the ATOM methodology (see chapter 5), key decisions on the project's PRM process and Risk Management Plan (RMP) should be made in an explicit initiation meeting. The important function of such a meeting is to ensure that all important stakeholders understand the objectives of the project and the PRM process. For PRM to be effective, the different roles, responsibilities and challenges concerning the management of risk should be clear to everyone (client, subcontractors, HMC leadership and senior PM). As can be concluded from the definition of risk given in chapter 5, it is impossible to identify any risks until objectives are clearly defined and agreed upon. However in reality there are many cases where project objectives are either not clear, not agreed or not documented.

At HMC, there is no explicit risk initiation meeting where important stakeholders, the project manager and its sponsor explicitly discuss, agree and record project objectives (Interview 1 & 2, see appendix N). If one sets the right objectives it becomes possible to understand the risks involved within the project's scope and the required level of PRM application. Creating "awareness" on the risks involved in every project should be the start of every PRM process. However, this issue is not explicitly addressed in HMC's current approach. From the case study analysis (see appendix M.3.1) and evaluation of the NWH planning and budget (see appendix L), it can be concluded that there has been a huge underestimation of the complexity and risks within this project. From interviews with HMC management, it can be concluded that initially, decommissioning projects were not perceived to be more challenging than installations (interview 2 & 16, see appendix N). Because many drawings, tools, lifting points and other engineering aspects were already there, one could "simply" reverse the old installation process.

The risk meeting at the start of each project provides an important function to make sure that every party in the project's organization recognizes that risks and uncertainty are inevitable, and therefore welcomes the benefits of effective PRM. In doing so, one should aim at balancing the preferred risk attitude and approach that suits the project's scope and objectives.

6.3 Risk Identification and Assessment – The Risk Workshop

After the objectives, scope, responsibilities and focus of the PRM process are clear, the next step is to identify and assess all knowable risks that affect project objectives. Some believe that this is one of the most important steps in a risk management process, because *"failing to identify a risk means taking it with your eyes closed"* (Hillson and Simon, 2007). It is therefore important that enough time and effort is devoted to risk identification and assessment to make sure all knowable risks are being considered. As discussed in chapter 5, risks are associated with *"known unknowns"*, the things we know we don't know. Thereby illustrating the fact that there also exist *"unknown unknowns"*, things that have never happened before and cannot be foreseen no matter how many techniques we use. It is important to recognize that one should never adopt a false sense of security that it might be possible to identify all risks. Nonetheless, risk identification requires sufficient effort and openness from all project stakeholders, being familiar with the tools and techniques and having the right information on the project's scope and objectives (Hillson and Simon, 2007). This again indicates the importance of the risk initiation step, as one can never identify risks effectively without being clear of the project's objectives.

At HMC, risk identification and assessment takes place in a risk workshop attended by the project/tender manager, project/tender team, appropriate specialists and the risk-coordinator (see appendix M.3.2). This workshop takes approximately 3 hours, with 30 min. for discussing the project's objectives, 90 min. for a risk brainstorm and then another 60 min. for risk assessment (interview 1, see appendix N). In HMC's PRM procedure, a fourth hour is included for the identification of mitigation actions. However as most workshops last for three hours, there is often too little time to carefully discuss responses and actions among the workshop attendees. When comparing HMC's risk workshop to what is considered "best practice", there are many differences that can be identified of which the most prominent is the workshop's duration. Where HMC has limited the risk workshops duration to 1-3 hours, the ATOM methodology prescribes that such a workshop should last at least 1-3 days. Initially, the process HMC applied for the management of its risks within the QESH department took a couple of days as well (interview 26, see appendix N). However when the process moved to the Legal Department, it was argued that by changing the workshop's outline the total duration could be brought back to a couple of hours and still be able to collect all the necessary information. Accordingly, the agenda of the workshop contains all the necessary elements for effective RM, but there is only little time for a fruitful discussion among all stakeholders to agree on the identified risks and their importance. Best practice PRM prescribes that

a risk workshop should not solely be focused on generating a large quantity of information for the project's risk register, but should also be aimed at creating a mutual understanding among all project parties on the project's risks (Hillson and Simon, 2007). Discussions and interaction are therefore essential to safeguard the quality of the data generated, for which sufficient time is necessary.

Because of the long duration of many risk workshops (like for instance the safety risk workshops mandatory for all offshore projects), such activities are often being perceived as costly, time-consuming, ineffective and boring as people lose their interest along the way (Murray Webster and Simon, 2007). Hence, it is important to make the risk workshop both exciting and effective, which requires careful preparation and facilitation by a risk coordinator.

Risk workshop preparation entitles inviting the right people and providing them with information on the workshop's agenda and some preliminary reading on the project objectives or business case. At HMC, the risk coordinator is responsible for facilitating the risk workshop and determines in correspondence with the project manager who should be invited (see appendix M.3.2). The people present at the workshop all bring their own specialized knowledge to the table, which stresses the need to invite all project stakeholders. Accordingly, a good mix of people is important to insure that commercial, technical, environmental and operational risks are being identified and discussed. From interviews with HMC it can be concluded that in many risk workshops, there are no operational people present that should provide important inputs from practice (interview 1, 2 8, 10, 11, see appendix N). Furthermore, there are no subcontractors or external parties invited that also hold project specific risk information that is of great importance to HMC (interview 1, see appendix N). As a result, the risk workshop mainly focuses on HMC's internal organization instead of taking all important stakeholders into account (those who have been identified in the previous stakeholder analysis). Next, attendants receive the workshop's standard agenda but no preliminary info on the project's objectives. HMC reasoned that in practice, only a few will read this information causing an uneven instead of a flying start of the actual workshop. To ensure that everybody remains open, creative and motivated, each HMC workshop is facilitated by an experienced risk coordinator. The risk coordinator of HMC provides a valuable introduction, keeps the workshop to its agenda and provides assistance when necessary (see appendix M.3.2).

6.3.1 Risk Identification – Brainstorm, Rationalize and Describe

The risk workshop starts with a series of introductions to the risk process, the risk workshop itself, the attendees and the project under discussion (Hillson and Simon, 2007). At HMC, the risk coordinator gives a short presentation of the risk management procedure, clearly indicating its focus on both threats and opportunities (interview 1, see appendix N). As can be seen from chapter 5, this is in compliance with the current "best practice" definition of a risk. Next, the Tender or Project manager gives an overview of the project's scope. From the case study analysis, it can be concluded that this presentation is mainly focused on the technical scope of work, rather than giving an overview of all specific project objectives (see appendix M.3.2). In some cases, this may create clarity on the activities within a project, but not of the specific standards, milestones, specifications and constraints that cause risk to these activities.

For the identification of risks, HMC uses a phased brainstorm. The reason to use a phased brainstorm is to make sure that everybody participates in the brainstorm. Within a group, there are always people that like to hear themselves talk a lot and tend to control the meeting. So to make sure that everyone gets an equal say, the session starts with an individual brainstorm. Workshop attendees are first requested to identify risks individually, describing each risk on a separate post-it,. Then, these risks are shared in small groups of three for clarification and to enhance interaction. Finally, each group appoints a person to explain the identified risks to the rest of the group, and then sticking each risk to the wall.

During each risk workshop, there is a short discussion on how to structure the risks. Depending on the choice of attendees, risks are either grouped by their relevant sources or by different phases of

the project's planning. From participating in the workshop and interviews with HMC personnel, it can be concluded that there is both an upside and downside of a phased brainstorm (interview 1, 2 & 12, see appendix N). The upside is that everybody gets the opportunity to put his ideas on the table and there are not a few that determine the outcome of the brainstorm. On the other hand, much time is needed to take out double risks as most people identify the same risks but write them down somewhat differently. So in fact part of the brainstorm is not a brainstorm, but a discussion on which risks are duplicates and should therefore be excluded. This may hamper the spirit and focus needed for generating as much ideas as possible, without criticizing, reviewing or discussing them. Hillson and Simon (2007) indicate that the ground rules of brainstorming are that there is no criticism, a focus on quantity of ideas, an opportunity to build on each other's ideas and that out-of-the-box thinking is encouraged. So in fact, there is a short individual brainstorm in HMC's workshop, after which people immediately start reviewing, clarifying and discussing each other's ideas to come to a common understanding instead of effectively identifying more risks from their interaction. Best practice PRM tells us that it is better to rationalize on risk duplicates apart from the brainstorm; as such discussion might stifle the creative process and hinder effective risk identification (Hillson and Simon, 2007).

Another problem that was indicated by HMC management was that there is little time devoted to out-of-the-box thinking (interview 2 and 12, see appendix N). Many of HMC's risks workshops are very effective in harnessing people's initial ideas on risks, but lack the required means to promote creative, wild, exaggerated and unusual ideas that may give rise to additional risks which would otherwise not have been foreseen. The ATOM methodology therefore prescribes to use additional techniques for the identification of risks next to the commonly applied brainstorm:

- **Assumption and constraint analysis**, where focus lies on questioning and reviewing implicit assumptions that were made in the conceptual phases of the project's development
- **SWOT-analysis**, a strong tool for identifying organizational strengths and weaknesses that might provide additional risk and require specific attention
- Next, it is possible to use **risk checklists**, a **risk breakdown structure**, the **project's WBS** and **risk registers from similar projects** to further stimulate out-of-the-box thinking.

Raz (2002) indicates that one should distinguish among risk identification tools for simple and more complex projects. Since there are a lot of tools available, more research is needed to find out what works best in projects with a different, type, focus and level of risk. Furthermore, Murray-Webster and Simon (2007) indicate that an important aspect to make risk workshop exciting is to vary common techniques and practices in order to inspire participants rather than bore them to death.

Apart from how many techniques, time and effort is devoted to the identification of risks there is another issue that came forward from the case study analysis. From reviewing HMC's documents it can be seen that most risks that were identified are threats, and that there is little focus on opportunities (see figure 22 in appendix M.3.2). While HMC's procedure explicitly recognizes the positive and negative side of risk, people still tend to associate risks with potential harm. And once we start thinking negatively about risk, it is very hard to switch back to the idea that a risk can also be an opportunity (Loosemore et al., 2006). Accordingly, HMC has developed a special "*added value capturing*" procedure to identify and assess opportunities. For this process there is a separate meeting among the project team and a number of key persons to identify a list of "values" that might improve the achievement of project objectives. This procedure has been developed in 2007, but from the case interviews it can be concluded that it is rarely used (interview 2, 8, 11 & 14, see appendix N). Moreover, there is no explicit integration of the results of this procedure with the risk management process, making sure that all opportunities are added in the same format to the risk register and will fall under the risk management system for their monitoring and control. So in fact there are still little opportunities identified and managed within HMC's PRM process.

The final element of risk identification consists of clearly describing each risk as an *uncertain event* (which might happen or not), with a certain *cause* and *effect* on project objectives. As can be seen from the analysis in section 5.2.1, this step is crucial to make sure that the risk register contains “real risks” that can be managed proactively by implementing specific actions. During the HMC risk workshop, attendees are asked to clearly describe each risk on a “risk input sheet”. Such a sheet used the following framework, distinguishing among cause, effect and consequence (see figure 23 in appendix M.3.2.d):

- **ATOM definition of risk:** “As a result of <definite cause>, <uncertain event> may occur, which would lead to <effect on objective(s)>”.
- **HMC definition of risk:** “There is an event <cause>, that will result in <effect>, that will lead to a <consequence on objective(s)>”.

From the difference in risk definition between “best practice” PRM and HMC’s approach, it can be seen that HMC associates the actual “risk event” as being the cause. And the effect of this event is separated in a certain “effect” and “consequence”, which actually imply the same thing. It can therefore be concluded that HMC’s input sheets and risk register are confusing and do not promote a good description of a risk, clearly separating it from uncertainty. It can be seen from HMC’s risk registers that people describe the uncertain event as being the risk’s cause, not mentioning which project characteristic or uncertainty is perceived as the actual cause of the risk. Next, the same effect is described in both the “effect” and “consequence” area. As a result, there are many duplicate, non-risks and general uncertainties in the risk register that cannot be managed effectively by the risk process (see table 12).

table 12 Examples for HMC risk registers that give no clear description of risk, using HMC definition of risk

CAUSE (There is an event that)	EFFECT (that will result in)	CONSEQUENCE (budgetary)
<i>500 T block overhaul not finished</i>	Increased Hermod duration	Schedule and cost increase
<i>Subsea activities take more time</i>	Subsea scope not finished in 2008	Increase in offshore duration
<i>Previous project delayed</i>	Increase in costs for subcontractors	Cost increase
<i>People not adhering to procedures</i>	Offshore work is delayed	Increase in offshore duration
<i>Asbestos removal on critical path</i>	Asbestos removal on critical path	Schedule increase
<i>ROV pilots not properly trained</i>	Delays during jacket removal	Increase in offshore duration

From table 12, it remains unclear why the 500T block might not be finished, or subsea activities might take more time. Because the cause remain absent, it is very difficult to develop an effective response for these risks. And is the “bad training of ROV pilots” a definite cause of the risk that ROV pilots will perform badly offshore, or is it an event that still could happen? Separating the uncertain event from its definite cause and effect on objectives gives clarity on the perceived risks and the means to address these risks proactively (see table 13 for some examples). Therefore it is crucial to describe risks separate from uncertainty in the project’s risk register.

table 13 Examples of good risk descriptions from HMC risk registers, using ATOM definition of risk

DEFINITE CAUSE	UNCERTAIN EVENT	EFFECT ON OBJECTIVES
Cuts have to be made between 0-25 m of water depth	<i>ROV has less workability above 25m of water depth</i>	Cutting time for cuts above 25m of depth longer than estimated
Caissons removal has not been assessed in tender	<i>Caissons have to be removed on critical offshore path</i>	Increase of offshore duration, Increase of project revenues
More suppliers on SSCV	<i>Offloading of suppliers comes on critical offshore path</i>	Increase in offshore duration, Increase of project costs
Subcontractor X is a small company	<i>Resource restrictions during engineering and offshore phase</i>	Delay in project milestones
Not all rates are provided in project contract	<i>Extra work or reimbursable scope not covered by contract</i>	Increased project costs for scope changes

6.3.2 Qualitative risk assessment – Using effective tools for prioritization

After risks have been identified, the risk workshop continues with assessing risks on their relative probability and potential impact on project objectives. HMC uses (like most risk processes) a probability and impact grid (PI-grid), or risk matrix, to assess the relative importance of each risk (see appendix M.3.3). This makes it possible to determine which risks require direct attention and which have such a minor effect on project objectives that don't require any treatment at all.

Risk assessment is always perceived to be a difficult activity as everybody has a different opinion on the severity, probability and effect of each risk (Interview 1, see appendix N). Hence, the perception of the importance of each risk is highly subjective, dependent on one's attitude, experience, knowledge etc. As it lies outside the scope of this thesis to explore the psychological biases and that affect risk assessment into detail, it should still be noted that there are all kinds of conscious and subconscious bias that affect the way people think about risk (see chapter 8). The most prominent bias is that when we think that something is very likely to happen, we believe "it can't hurt us" and so the impact should be low. While on the other hand if we think that something is very unlikely to happen, it might have the most catastrophic impact (Murray-Webster and Simon, 2007).

Accordingly, it is very important that the tools used for risk assessment are clear, effective and efficient to generate specific knowledge on each risk in a minimum amount of time. Within the workshop HMC applies, attendees use the same risk input sheet to assess each risk after it has been identified. In small groups of three, attendees discuss both the probability and impact of each risk and determine its severity on a five-point qualitative scale ranging from Very Low to Very High.

The scale HMC uses for the probability of a risk ranges from 0,2% up to 50%, organized in a non-linear manner. However the focus of the probability scale is on the past, rather than on the future. Each probability number (1-5) represents a percentage of which is perceived the risk event has happened sometime in the past, e.g. a probability level of 1 means "*has happened in the last 10 years*", and a probability level of 5 means "*happens once every month*" (see appendix M.3.3). Hence people are asked to assess a risk on their feeling that a risk will happen, based on their past experiences, thereby neglecting the differences and changes of circumstances. This may cause significant bias in how people at HMC estimate the probability of occurrence. Next, respondents are asked to specify which project objectives are affected by the risk (e.g. vessel days, engineering hours, costs etc.). However for the assessment of risk there is just a single overall impact scale. Consequently, there is no difference between the severities of a risk's impact on time, quality or cost objectives (see table 14)

table 14 ATOM: Project specific impact scales (Hillson and Simon, 2007)

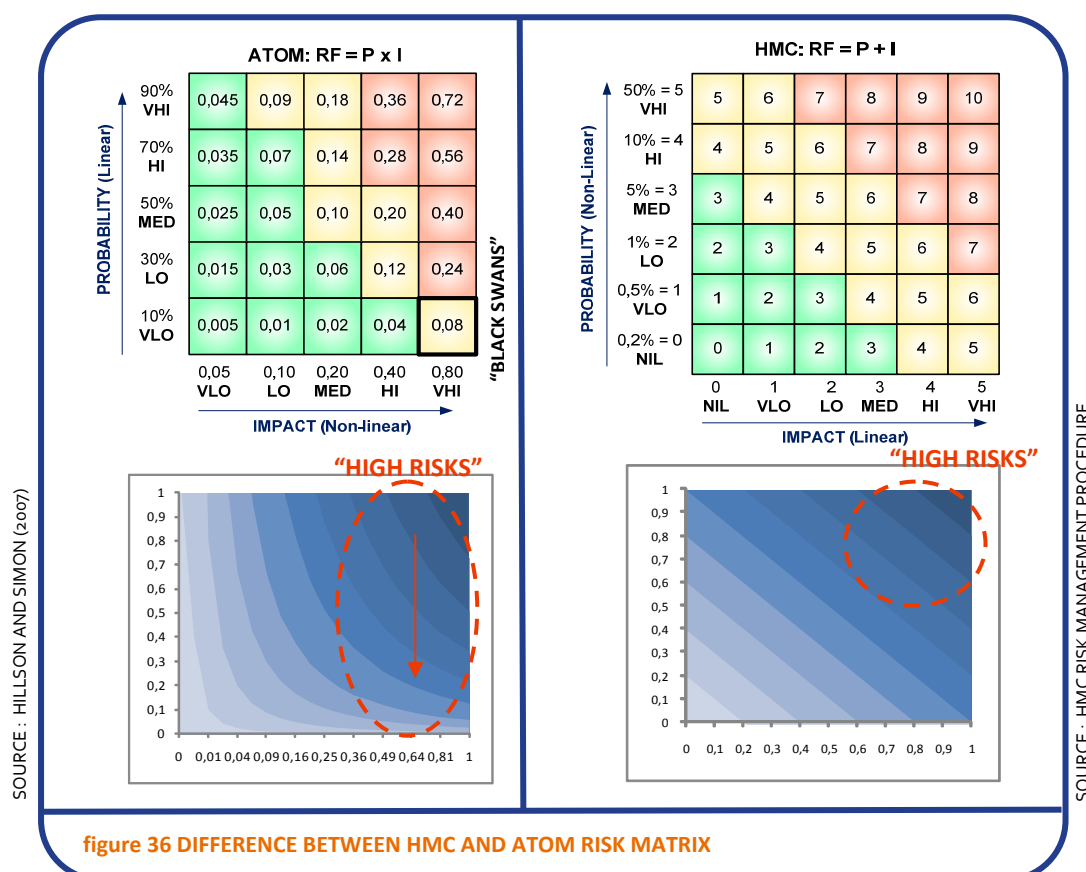
SCALE	PROB	TIME	COST	QUALITY
VHI	71-99%	>20 days	>\$200 K	Very significant impact
HI	51-70%	11-20 days	\$101K-200K	Significant impact
MED	31-50%	4-10 days	\$51K-100K	Some impact
LO	11-30%	1-3 days	\$10K-50K	Minor impact
VLO	1-10%	< 1 day	<\$10K	Very little impact
NIL	<1%	No change	No change	No change

HMC: General Scale

SCALE	PROB	IMPACT
VHI	~50%	5
HI	~10%	4
MED	~5%	3
LO	~1%	2
VLO	~0,5%	1
NIL	~0,2%	0

From the case study analysis it can be concluded that many people at HMC find it very difficult to assess a risk's impact as the procedure used for risk assessment does not clearly specify what is meant with "low" or "high" and if one should consider the impact against the whole project or just against the schedule, the scope, the cost or the quality (Interview 1, 5 & 13, see appendix N). From HMC's risk documents it can be seen that sometimes people give two impact numbers as they simply cannot agree on the value that best describes their feelings. "Best practice" PRM uses project specific impact scales, clearly specified for each of the relevant project objectives (Hillson and Simon, 2007).

Because when a risk has an effect on both the project's budget and schedule, while at the same time the "impact" level is determined "high". There still remains confusion if there is a high cost impact, a high schedule impact or for instance a high schedule impact that might result in additional costs. To most of HMC projects, the main cost driver is the project's offshore duration (See appendix L). Hence, every offshore delay is directly perceived as having a major effect on project costs, while in fact the risk does not directly cause additional expenses. As these issues quickly become entangled during risk assessment, many consider the current risk procedure more guessing than that it effectively supports discussion on the priority of each risk (interview 2, 6, 12, 8, see appendix N).



When the probability and impact of each risk has been estimated, it is possible to use a risk matrix for the prioritization of risks (both threats and opportunities). To do so, one can use a risk's probability and impact to calculate a "risk factor" that entitles a quantitative value for the relative importance of each risk. From the case study analysis, it can be seen that the risk matrix HMC uses differs significantly from a best practice risk matrix (see figure 36). The ATOM methodology specifically addresses the need to use a *linear scale* for risk probability, and a *non-linear* (or logarithmic) scale for impact, to accentuate impact over probability. Because one should be more worried about something that will "kill" the project but is very unlikely to happen, than something that is almost certain but will do little harm. However one should take care in using risk factors, because the risk matrix may neglect the risks that are highly unlikely but may be catastrophic (**black swan** risks). Black swan risks are risks that "lie outside the realm of regular expectations" but carry an "extreme impact" (Taleb, 2007). In most cases, the risks that are very unlikely to happen but have an extreme impact are neglected by risk matrices. As can be seen from figure 36, high impact risks with a low probability only receive a moderate risk score. While in fact, these risks often have a devastating effect on the project as they occur hence they require a specific focus in the PRM process. Using a logarithmic scale for risk impact and a linear scale for probability ensures a heightened focus on black swan risks, as can be seen from figure 36.

The HMC risk matrix uses the *sum* of a risk's impact and probability to calculate the risk factor. And as the scales are both linear there is an equal focus on the probability of a risk compared to its impact. It can be seen from figure 36 that a risk with a VLO impact and a VHI probability has the same risk level of importance as a risk with a VHI impact and a VLO probability. So in fact the HMC procedure merely categorizes risks in 10 "risk groups" instead of that each risk is prioritized on its relative level of importance. Moreover, the actual probability scale that is used (0,2% - 50%) does not correspond to the scale used for prioritization (1-5). It is interesting to note that in the initial presentation of HMC's risk process there is a clear formula presented for the quantification of a risk, being the probability times its impact, while this formula is not used for risk prioritization.

6.3.3 Risk Categorization and Ownership – Structuring Risk Information

The final element of the risk workshop should make sure that there is sufficient information and agreement among the project's stakeholders to ensure that effective responses are developed and implemented. "Best practice" PRM recognizes two activities to do so, e.g. categorizing risks and dividing risk ownership (Hillson and Simon, 2007).

At HMC, there is no specific categorization of risks according to their source or perceived effects (see appendix M.3.3). During the brainstorm, a certain structure is used to temporarily group risks, but this information is not recorded on the risk inputs sheets. Therefore it remains unknown if the risk applies to the entire project or to a specific phase within the project. Next, there is no categorization on the source of each risk to identify common drivers of risks in the project that require specific attention. The structuring of risks is essential for understanding the amount of positive risks compared to negative risks, specific risk hotspots and focus areas. Furthermore, this allows the effective allocation of risks to the people that should be responsible for their management (see appendix M.3.3).

A risk workshop should conclude with nominating a single *risk owner* for every risk. A risk owner is the person within the project's organization that can best manage the risk according to his tasks, responsibilities and experience. It is essential that each risk is assigned to a single named individual and not a group of people or a functional department (Hillson and Simon, 2007). Eventually, there is only one person responsible for making a decision on the risk's management. When such a responsibility is assigned to an entire group of people, experience teaches us that in most cases nothing happens (Interview 2 & 10, see appendix N). At HMC, risks are assigned during the final phase of the workshop on the input sheets. As can be seen from the case analysis, many risks are assigned to several persons or even an entire department (see appendix M.3.3). For example, a single risk in the risk register was assigned to the following "risk owner": PM, Engineering, Management Team, Tender coordinator, Project manager, Tender manager and Project Engineer. But in the end, who is going to take action to manage the risk, taking on the responsibility for its causes and effects? One problem of the fact that HMC allocates risks in small groups is that it is very easy to push risks to the one person that is *accountable* for all risks, the project's manager. However in a project with over 300 risks, the project manager cannot develop actions and plans for each and every risk. Hence, the *responsibility* for the *management* of a risk should be divided among key decision-makers within a project's organization along the specified framework of responsibilities, who in turn, are managed and coordinated by the project manager.

6.4 Quantitative Risk Analysis

After risks are identified and assessed, using qualitative methods, one might decide to analyze these risks into more detail using quantitative techniques for analysis. The qualitative risk register thereby functions as a starting point for quantitative analysis, in order to determine the chance that the project is completed on time and within budget, identify critical project drivers, determine the project's success rate and assist in making decisions among various alternatives. However the

outcome of such analysis can be meaningless if one not uses the right inputs and techniques to generate a valuable outcome, for which is often referred to the axiom “*Garbage in – Garbage Out*”. (Nolder, 2009)

Accordingly, best practice PRM suggests to only use quantitative analysis for projects that are large or high-risk, where their investment and required efforts can be justified (Hillson and Simon, 2007). It is widely recognized that effectively performing quantitative analysis requires a lot of effort, resources and time from all project stakeholders to generate a valid outcome. Nonetheless, research by Raz and Michael (1999) among 400 project managers in various high-tech industries shows that out of 40 different PRM tools, quantitative simulation is ranked as the best tool for analyzing and managing risk. It contributes significantly to both the effectiveness of the risk process as well as the achievement of project objectives. Another empirical study by Raz et al. (2002) among a 100 projects shows that quantitative analysis is specifically helpful in avoiding time and budget overruns.

For an offshore marine contractor like HMC, business success depends for a large part on the effective estimation of project costs and duration (Interview 4, see appendix N). At HMC, all projects are driven by the amount of offshore vessel days required for the project’s execution. The offshore duration greatly affects the financial balance of the project, as most of the project’s budget is spent offshore. This can be seen from the analysis of the NWH project (appendix L), where the offshore schedule’s delay has been the main contributor to the project’s negative financial outcome. Consequently, QRA is considered to be a powerful and important tool for HMC, as it gives an overview of the project’s risk and uncertainty. Also it assists management in making realistic budgets/schedules and setting the right contingencies to increase the chance of project success.

HMC applies quantitative risk analysis to all of its projects, using a pre-developed Monte Carlo model to analyze the overall risk level on two dimensions: the project’s offshore duration and financial result (interview 1, see appendix N). A standard model has been developed in 2006, using an excel spreadsheet in which project specific risk values are entered for analysis. Each risk is represented by a probability distribution, of which the Monte Carlo model takes a randomly selected set of values to calculate a possible project outcome. This process is repeated by the computer over and over again (for example 10.000 times) so that a range of possible outcomes is generated, e.g. the “*project’s risk footprint*”.

It can be concluded that after the risk workshop, a lot of time in the HMC risk process is devoted to QRA and Monte Carlo simulation, providing the Project/Tender Manager with a continuous update on the overall risk level of the project. However as the model has only recently been implemented at HMC, there is still little known of its effectiveness and use in practice. Because of the large overrun of the NWH project and the importance of quantitative risk analysis to HMC’s business, this thesis also analyzes the HMC process for quantitative risk analysis. However it should be noted that the main focus of the research project is considered with the overall risk management process, to which quantitative methods might provide an extra level of detail. Hence, the analysis set out in this chapter focuses on the principles for effectively applying quantitative risk analysis tools to *support* risk management, rather than specifically evaluating the outputs and inputs of the model applied in current projects. Accordingly, the methodology behind the process for effectively applying Monte Carlo simulation techniques is compared to HMC’s current practice.

6.4.1 The principles of Quantitative Risk Analysis – Make a “simplified” project model

The idea of quantitative risk analysis is to use a simplified model of the project that incorporates all uncertain areas and their relations. Such a model should be designed to examine the impact of risks on key items within the project’s schedule and budget, and thereby show how these interact which each other and proliferate risk throughout the network. Accordingly, quantitative analysis is not simply a simulation of every individual risk, which is then added up to form the overall project risk

outcome. It is about the specific analysis of the effect of risks within a predefined project plan or network structure, creating an understanding on the plan's ability to cope with change.

Consequently, it is essential that the risk model has the right level of detail and focus to produce a valid result. Such a model should not be too large, making it very difficult to remain oversight and gather the required inputs. But on the other hand the model shouldn't be too small either, failing to express the inherent interactions and interdependencies among different activities and risks.

Best practice PRM prescribes that a good risk model should draw its structure from a typical level 2 project schedule, made up out of in between 150 to 300 activities that effectively captures the logic and sensitivities in the project's plan (Hillson and Simon, 2007). From the case study analysis it can be concluded that the current model HMC uses is not built on a specific project structure, schedule or CBS structure (interview 1, see appendix N). Hence, *there is no opportunity to map risks to specific project activities, simulating the interaction of multiple critical paths and addressing the interaction of risks*. HMC's model simulates each risk separately and then combines the result to form an overall picture (grouped by the specific project phases). The more complex a project, the more parallel paths and interconnections exist that either proliferate risk from one area to another or might provide slack to diminish a risk's effects (especially in complex EPRD projects). The essence of quantitative analysis is to simulate these effects; however this can only be done when a project specific model is used.

6.4.2 Generating Quantitative inputs – Breaking our tendency towards precision

Apart from using a project specific model based on a level 2 schedule, the results of quantitative analysis are highly dependent on the validity of the model's input. Again, this data should be deliberately coupled with the project's plans and estimates. Murray-Webster and Simon (2007) indicate that in practice, our project schedules and cost plans are always guesses, based on our best estimates. And for some projects, our experience, knowledge and data of past projects can make these "guesses" as educated as possible. However when a project is done for the first time, it is highly unlikely that our guesses are correct. Nonetheless, our project's clients and sponsors demand deterministic plans that give a "precise" representation of the project's duration and cost outcome. In fact, it is often forgotten that these plans are made up out of many uncertain estimates. Simon (2007) gives that our "drive" towards precise (single point) estimates stems from the fact that it is culturally unacceptable to provide range estimates. But in fact, we are far more accurate in estimating an uncertain value when asked to provide a range or *three-point estimate* (e.g. the minimum, most likely and maximum value).

- **Minimum value:** An optimistic estimate of what might happen, assuming that everything goes well
- **Most Likely:** This is the estimator's best bet, presumed to be the "most likely" outcome
- **Maximum value:** This is a pessimistic extreme, assuming that the worst tends to happen.

Empirical research from Capen (1976) confirms this notion, showing that people have the tendency to overestimate the precision of their own knowledge, while at the same time underestimating the potential for unexpected events (see optimism bias section in chapter 8). Thus, project schedules and cost estimates in uncertain situations are prone to be understated.

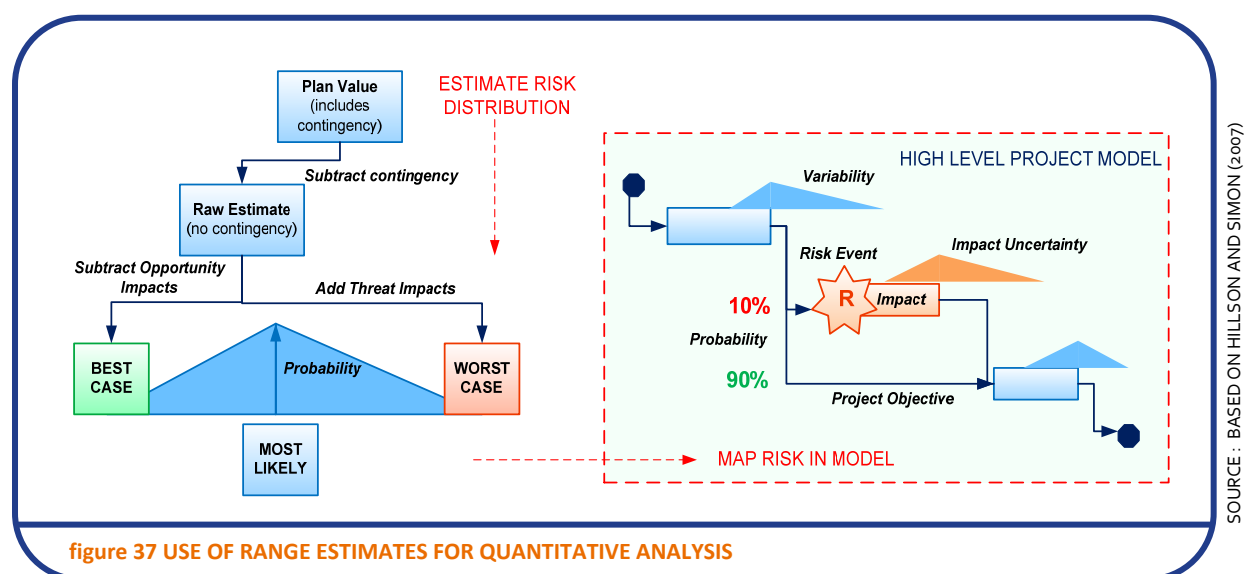
Not surprisingly, QRA is all about using three point estimates to provide a more "accurate" range or distribution of the uncertainty associated with initial project plans, activities and their risks. Using these range inputs to express our uncertainty to the current project plan, it becomes possible to simulate the project and compare the eventual distribution of possible project outcomes with our deterministic plan, giving important implications for adjustments and expressing the chance that the project will meet its deadlines.

It is however essential to distinguish among "*uncertainty analysis*" and "*risk analysis*". As argued in chapter 5, there is a distinction between uncertainty and risk that is crucial for effective quantitative

analysis. On one hand, there is uncertainty about our initial estimates which we will refer to as variability. And as many of our project estimates are “*educated guesses*”, they are in fact uncertain and may turn out better or worse than expected. Within this thesis, the use of three point estimates for estimating the uncertainty of our planned activities and budget items is considered to be “*project uncertainty analysis*”. Next, there are a number of threats and opportunities (uncertain events) that might affect activities or the project as a whole, and cause beneficial or adversely effects. These “*uncertain events*” or risks have a certain probability and impact, while this impact again might be uncertain and thereby estimated with the use of a risk distribution or a three point estimate. Estimating the effect of risks in the project’s model and schedule is considered to be “*project risk analysis*”. This distinction is essential for effective quantitative risk analysis, however in practice rarely made explicit.

At HMC, there is no distinction between the uncertainty that affects planned activities (*variability*) and the uncertainty of risk impacts (*impact uncertainty*), that cause an additional delay or benefit to the project’s outcome (see figure 37). In most cases the HMC model estimates variability as the combination of both a positive and negative risk. For instance, in every schedule there is a certain amount of weather delay included which in fact is a calculated “*best estimate*”, for which a marine engineer uses a specifically designed risk analysis model (see appendix M.2.4). While in fact, the outcome of this model has a range with a calculated P10 and P90 value to indicate the uncertainty of the outcome. But in the HMC project risk analysis model, “*weather uncertainty*” is analyzed as two risk events, e.g. there is a 10% of the P10 weather delay (opportunity) and a 10% of the P90 weather delay (threat).

The same counts for other uncertainties like “*increased cutting time*” or “*not making engineering milestone*”. These are both uncertainties that can be modeled against current estimates, while in HMC’s model they are analyzed as risks that have a certain chance of occurrence and impact. Furthermore, it is important when quantifying an uncertainty or risk that one takes into account the contingencies that are already included in the schedule and budget. Because in many cases when an estimate is uncertain, people have already taken care of some of this uncertainty in the initial project plans. Hence, in reality the eventual outcome can be both *better* and *worse* than the current plan. Failing to acknowledge this fact means that the overall risk analysis is negatively biased, as the project’s contingencies are not explicitly incorporated in the risk estimates. This effect is clearly present in the HMC’s risk model, as there is no rationalization and evaluation of risks compared to planned contingencies, causing an overall negative bias (see figure 37).



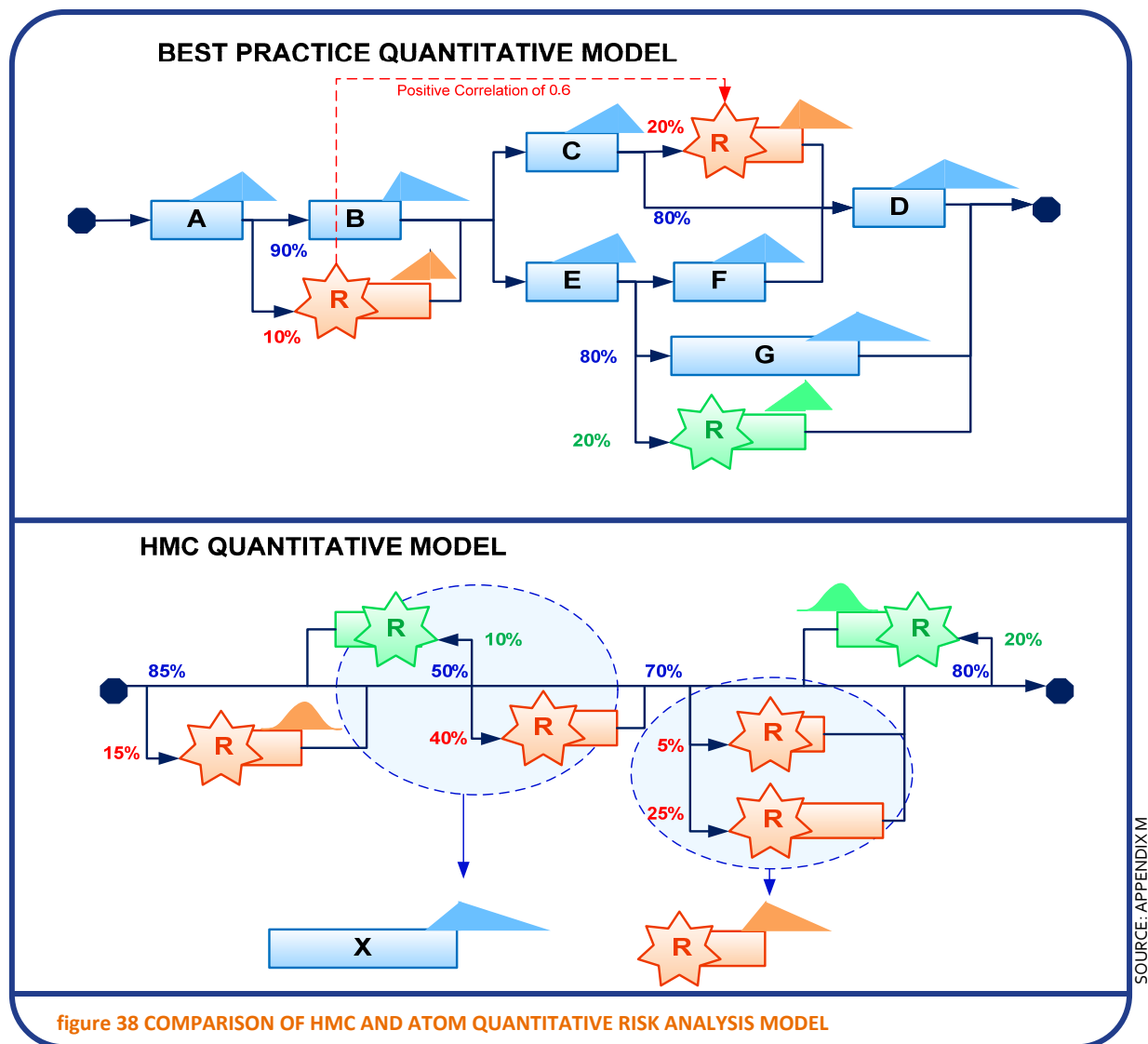
Apart from how the model estimates variability or uncertainty, there is no use of range estimates for most of the risks in HMC's model. From analyzing HMC risk documents, it can be seen that almost all risk events are modeled using a "discrete" distribution (see appendix M.3.4). This means that there is only a single impact estimate for the risk's outcome, while in fact it is very hard to estimate such an outcome. As discussed earlier, using three point estimates would give a far more accurate estimation of the perceived risk and its effect on objectives. However in the current model there is no possibility to use three point estimates, because one can only choose between a Normal, Discrete or Poisson distribution. To counterbalance this effect, some risks are split up within the model to indicate the uncertainty associated with a risk impact. For example, there is a 5% chance of a small schedule delay and a 35% chance of a large delay because of risk X. So the same risk is in fact modeled twice, while it would be far more accurate to use a single risk but indicate its impact uncertainty with a range estimate, made up out of a minimum, most likely and maximum value for its effect (see figure 38).

The most important difference between best practice risk analysis and the HMC Monte Carlo model is the lacking ability to show how risks interact with each other throughout the project's network. The default condition for a Monte Carlo simulation is to assume the total randomness for all the uncertain variables in the model. While in fact, this does not reflect reality as there are many influences and correlations among activities and risks within a project, especially in complex projects with multiple critical paths. This allows one risk to increase the existence and impact of others, and these "*event chains*" are one of the reasons why we highly underestimate risk in complex projects (Nolder, 2009). To give an example from the case study analysis, if the risk occurs that the newly designed cutting tool is not tested properly, then there is a higher chance that it will break down offshore and result in a delay of the entire project. This delay then also increases the risk of bad weather as more time offshore means a higher chance of weather delays (**correlation**). Furthermore the *effects* of risks are calculated using the project's offshore day rate for a fixed number of barges and tugs. But when the risk occurs that has the effect that an additional tug is required, and the project is also delayed the actual costs for such a tug increase even further (**connectedness**). All these connections and correlations are crucial in effective risk analysis. The current HMC model however does not contain these specific relations, connections and correlations between project activities and their risks.

At HMC, the project manager and project controller estimate the quantitative risk input data for the model. Stepping through the risk register, the risk coordinator and project manager determine which risks should be included in the model and which not. Next, the likelihood of the risk is estimated and its effect in whole Vessel Days, Tug Days, Barge Days and additional costs or revenues. The model then automatically links the amount of vessel days to a fixed SSCV day rate to calculate the associated cost impacts of schedule delays. Hence, the variance in project duration is automatically linked and calculated in single model. However these estimates are all focused on the risk's effects on the entire offshore operation, making them very hard to estimate. In fact many risks apply to several specific offshore activities, for which the recurring effects are often neglected. For instance if one wants to simulate a 10% risk probability for a failing cutting tool, would that then mean that:

1. Every cutting tool has a 10% of breaking down during each offshore cut
2. There is a 10% chance that one of the cutting tools breaks down during the entire offshore campaign
3. Each cutting tool is unavailable during 10% of the offshore time
4. All cutting tools have a 10% chance of not working at all
5. Etc.

Accordingly, it is almost impossible to analyze such risks in a model by simply guessing the amount of extra vessel days. Best practice prescribes to explicitly discuss how risks should be included in the model and if there are already any contingencies in place. Consequently, effective QRA requires a lot of effort and time in order to collect valid data for analysis and should therefore only be used on large and complex projects (Hillson and Simon, 2007).



6.4.3 Using model results for decision support – Do we put our thrust in the numbers?

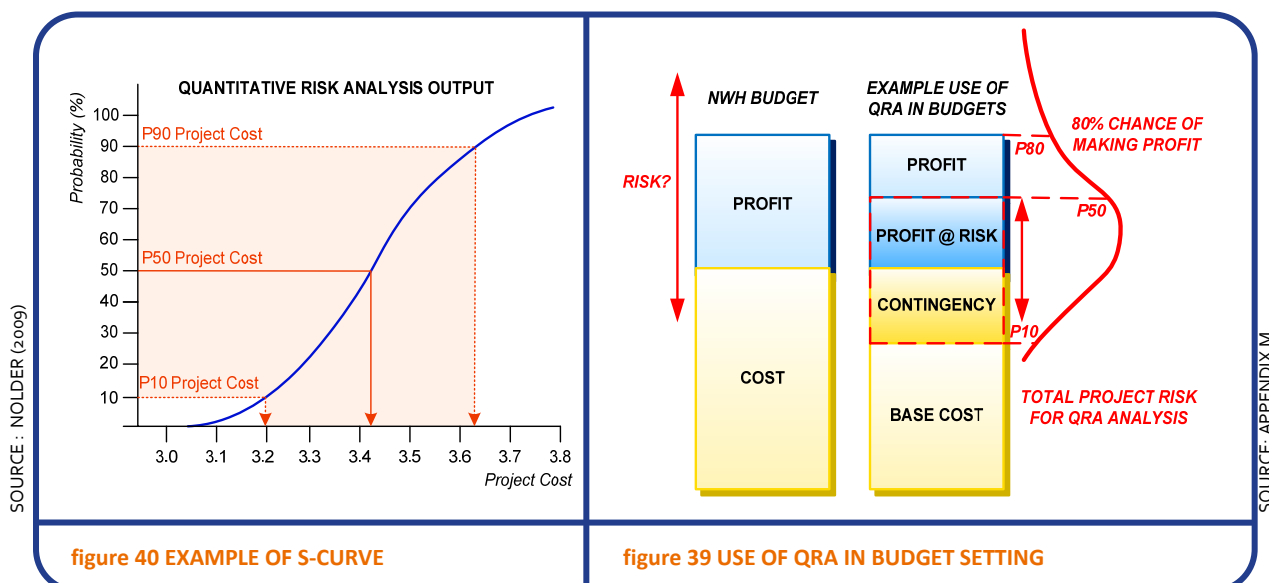
After the model is complete and all the risk distributions are entered, it is possible to let the computer simulate the project (together with its risks) for thousands of times to provide us with a range of possible project results. At HMC, the model analyses the current risk profile of the project, assuming that all developed risk responses and mitigations are already in place (post-response analysis). However by doing so, one neglects the benefit of a risk model to explicitly show the effectiveness of the risk process and its efforts.

Best practice PRM prescribes to perform quantitative risk analysis in two discrete stages (Hillson and Simon, 2007). First, use the model to simulate the project's current risk exposure without any consideration of planned mitigations or risk treatment actions. Next, repeat the process but include planned responses to show the effect of planned risk management actions. Doing a pre- and post-response analysis has two important benefits to the risk process. First, one can use pre-response results to check the validity of the model and ensure more effective risk response planning. The model gives insight into which risks are critical, providing management with explicit information on how much time, effort and resources should be devoted to their management. Secondly, one can show the difference between pre- and post-response analysis. Thus, it becomes possible to visualize the total effect of risk plans and the PRM process, creating confidence in the perceived result of taking proactive actions.

Next, the HMC model collects all the outputs of the analysis and plots them in an overall eyeball graph (see appendix M.3.4), giving the perceived P10, P50 and P90 of the project's financial result and offshore duration (see figure 40). All risks in the model are ranked on their relative effect on project objectives, and additional eyeball plots are given for the top 5 risks. As there are no planned activities included in HMC's model structure, the output represents the simulated deviation of the project outcome compared to current forecasts, providing an overview of the collective effects of all risks (interview 1, see appendix N). These results are then mapped in a PowerPoint sheet and send to the project manager for review.

In fact, the inputs for the model are provided by the Project/Tender Manager and the outputs are reported to the Project/Tender Manager as well. Hence the use, validity and effectiveness of the QRA are highly dependent on the project's manager perspective on project risk. While in fact, risk analysis should be a collective effort among all project stakeholders, providing an interactive tool for the project's management team to continuously compare alternatives, support proactive decision-making and modify the project's strategy to improve the chance of success. From the case study analysis, it can be concluded that within HMC, each Project or Tender manager has a different perspective on the importance and usability of quantitative risk analysis. Some see it as something of a black art, having little confidence in the eventual results as it remained unclear how the model outputs are related to the inputs. This indicates that in most cases the results are far too negative and difficult to read, giving that they are merely used as an overall indication instead of actually supporting decision-making. Others see quantitative analysis as an essential part of risk management which provides a basis for decision-making in complex and uncertain situations, providing the company's "best estimate" for setting schedule and budget contingencies (see appendix M.3.4).

The fact remains that in current projects the output of the quantitative analysis is rarely used in critical project meetings (Interview 2, 8, 10, 13 & 17, see appendix N). During the tender process, there is no review of the quantitative risk output to provide an indication of the chance of making a profit for a certain bid. In most cases, the respective Tender Manager reports on the top 5 or 10 risks and discusses how these are addressed in project plans, the contract or its estimates. But for instance in the NWH project, there were no explicit contingencies included in the project's budget structure to cope with the perceived uncertainties and risks in initial estimates (interview 6 & 12, see appendix N and figure 39). Within the project phase, there is a monthly progress meeting with all project stakeholders. However the results of the quantitative model are rarely discussed. Hence, the model is often used for risk prioritization rather than explicitly using the results to create flexibility within current plans.



6.5 Response Planning, Implementation and Reporting – From plan to action

So far, the steps in the risk management process that have been discussed are all about “*assessing risk*”. The knowledge from these steps is used within the entire organization to determine how much time and tools we should devote to identify, prioritize, and analyze project risks. However what is essential to actually “*managing risk*” is that all these efforts and information leads to effective responses and actions in practice. Hence, the PRM process should ensure that key decisions are made on how to actually manage the identified risks, using all risk information to change the project’s strategy, thereby improving the chance of project success. One of the most difficult but critical steps in a PRM process is to make sure that the risk process moves on from planning to action. Because simply understanding and describing risks does not change them.

As can be concluded from the analysis set out in chapter 5, best practice PRM explicitly addresses the issues of developing, communicating, controlling, monitoring and implementing responses and actions to change the project’s risk exposure. Planning and implemented risk responses is in many ways the most important step of the entire process, because effective responses to risk will increase the chance of achieving the project’s objectives. While failing to do so will not only rapidly deteriorate the project’s current position, but will also introduce new risks as implemented actions are ineffective. Hillson and Simon (2007) therefore indicate that an effective PRM process should explicitly and rigorously address risk response planning, so that actions are developed and implemented *proactively*.

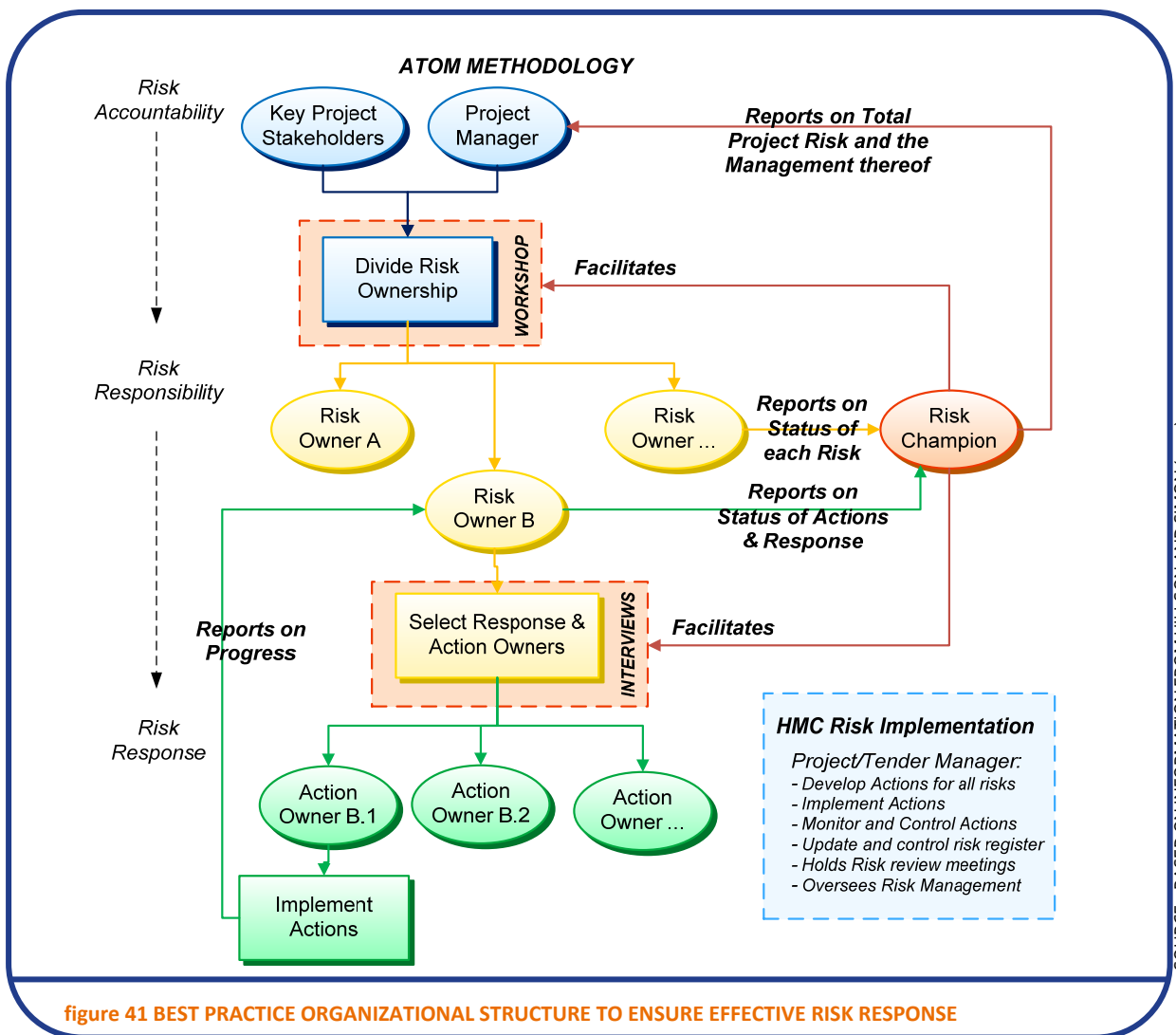
Various empirical studies (Raz, 2002; Ward, 1999, Kutch, 2005) on the subject of PRM practice show that this is the element where we often fail to make risk management work. Believing we are managing risk proactively, we quickly find ourselves reacting to problems which have already materialized. This in fact corresponds more to issue management than to effective risk management. Ronan Murphy, one of the senior risk managers of the Railway Procurement Agency of Dublin explains that “*most project managers prefer the excitement of proactive issue or crisis management rather than reflective or preventive risk management*” (2004). Terry Cooke Davies (2004) adds that when making a decision we find it much easier to refer back to a known past, rather than forwards towards an unknown future. Because for each risk, there is always a chance that it might not happen, making it far more difficult to substantiate a decision for a change of strategy or a specific amount of contingency. And after all, who wants to be reminded of all the possible disasters and problems that may lie ahead of us? Consequently many people share the notion that only by setting challenging targets the project team will be sufficiently motivated to achieve a high level of efficiency, instead of spending time on “*reasoning the project towards a potential disaster*”.

Another explanation why we often fail to implement and plan proactive actions is given by Murray-Webster and Simon (2007), who introduce “*the hero concept*”. This concept indicates that project managers who get the most praise are those who turn problematic situations into a successful outcome. However, there is often little attention devoted to why the project got into trouble in the first place, let alone the ability of the project’s manager to effectively plan and address project risks in order to avoid such a situation. Hence managers that have spent most of their efforts on solving problems are seen as the company’s heroes. While those who have prevented these problems from happening in the first place by proactively managing their risks and delivering all project objectives receive the comment “*it must have been an easy project anyway*”.

So in fact, there are many cultural, structural and reward based reasons why we fail to move from the analysis of risks to their effective management in practice. This thesis will focus on how we can address some of these issues in the PRM process. The focus will be on the development, implementation control of responses and actions to the identified risks within HMC, compared to what is currently perceived as “best practice” PRM for large and complex projects.

6.5.1 Response development, implementation and control – The Manager’s Responsibility?

One of the most important aspects of the ATOM methodology is that it distinguishes among *risk accountability* (who is responsible for the effects of a risk), *risk ownership* (who is responsible for managing the risk) and *action ownership* (who is responsible for implementing response actions). Because if there is no clarity on who is responsible for actually managing the identified risks, it is very easy to assume that the one person who is held accountable for the success of the project as a whole will take care of them: the Project Manager. Hence, best practice PRM prescribes that especially in complex and large projects, risks should be managed by those who have the best experience and knowledge to do so (Hillson and Simon, 2007). Thereby it is important to ensure that every risk is allocated to a specific *risk owner* (person who can best manage a risk) who in turn, develops specific actions that are implemented by *action owners* (person who should perform the action, figure 41).



At HMC, the actual development, implementation, control and monitoring of risk responses all fall under the responsibility of the Project or Tender Manager (See appendix M.3.5). So as the analysis of risks is for the greater part done explicitly with the support of an external risk coordinator, the actual use of this information for effectively managing risks is for the greater part still performed implicitly. According to HMC’s risk management procedure, a full hour of the risk workshop should ensure that all stakeholders identify specific responses and actions to the assessed risks. However in practice, there is often little time for risk response planning due to the scheduled 3 hours for the workshop.

From analyzing HMC's risk documents (see appendix M.3.5) it can be seen that many identified risks have no explicit mitigation response. For instance in the NWH tender, *less than 5% of the risks have been mitigated or treated*. And in the NWH project risk registers, the number of explicit risk responses to risks has not been higher than 50% of the total amount of risks in the register (see figure 33 in appendix M.3.5). Furthermore, because there is little time in the process for developing these responses, most are very cryptic and lack the required level of specification for effective management in practice (see table 15).

table 15 Responses to Risk from HMC risk registers

RESPONSES TO RISK	
"Good planning"	"Schedule for proper durations"
"Proper management"	"Change in mindset"
"Make system more flexible"	"Proper planning and management"
"Additional resources"	"Understand actual requirement"
"Plan for alternatives"	"Early commitment of contractors"
"Come with good arguments"	"Investigate in more detail"

Who should schedule for *good* durations? What is meant by *proper* management? When is it considered *early* to commit subcontractors? To *which detail* should the risk be investigated? As these questions remain unanswered it is very hard to move from risk assessment to actual management. The cryptic risk response descriptions, together with the assignment of multiple risk owners (see section 6.3.3) does in fact imply that it remains indefinite how project risks should and will be managed. Eventually, the entire project's risk profile and the hundreds of risks within HMC's risk register fall under the responsibility of the respective Project or Tender Manager. However, there is no explicit control, monitoring and reporting on the status of the specific risk response actions and their effects. It is therefore unknown what has actually been done, when, by whom and how it changed the perceived risks.

Accordingly, at HMC the Project/Tender Manager is the only person that has a realistic and up-to-date overview of the project's risk profile. And as discussed in chapter 4, it is almost impossible in large and complex projects for a single person to remain oversight of all the project's subsystems and their interactions, let alone their risks. Moreover, this raises the question what will happen to the project's PRM when the project manager gets sick or goes on a leave? There is no clear document that contains a structured overview of all the specific responses and actions for effective risk management that can easily be handed over to another project manager (see appendix M.3.6).

Consequently when implementing and developing risk responses in a large project, it is impossible for a single person to address each and every risk at once. In reality, it will always remains difficult to decide when one should take action, how long it will take to implement this action and how much time there is available to make such a decision. Some risks require immediate attention while others may be less urgent and thus might be considered in a later stage of the project. But when the time comes, it is often too late to take effective action because the cost of change has increased significantly. *"Managers constantly experience the pressure of making decisions today, with inadequate information that will be better known tomorrow"* (Terry Cooke-Davies, 2004).

Accordingly, best practice PRM prescribes to explicitly plan, check, report and monitor all risk responses and actions within the PRM process. This ensures that it is clear to everyone which responsibility they have in proactively addressing the project's risks. Especially in a large project with multiple hierarchical layers, there are specific subparts and teams that have their own management and responsibilities (see chapter 4 and appendix J). The management of risks should be divided as well, allocated to those who can best manage them, which in many cases is neither the project

manager nor the risk coordinator. These persons (the project's *risk owners*) will have to spent sufficient time and efforts on developing a specific response strategy, e.g. to *take, treat, terminate or transfer* the identified risk (see chapter 5). The ATOM methodology prescribes to use a risk interview with every risk owner to plan all actions and responses, facilitated by the risk coordinator. During such an interview, there should be enough time to compare different alternatives; think of the best persons in the organization to carry these out and decide which approach best suits the severity and urgency of the identified risk. For risk management to be effective, each response action should be described at the same level of detail as any normal activity in the project's schedule, having a certain budget, action owner, time span, completion criteria etc. This prevents a "blaming culture" as one can clearly check who is responsible for acting on the perceived risks and by what means. Currently, there is no explicit system within HMC's risk management process to develop such actions and to make sure that there is a collective responsibility within the organization to move from risk assessment to proactive action (see appendix M.3.7).

6.5.2 Controlling PRM – Managing risk as a cultural imperative

Apart from explicitly allocating risk responsibility to various people in the project's organization and spending enough time to plan specific responses and actions, best practice PRM prescribes to rigorously control and report on their implementation through the PRM process. This ensures that there is a continuous update on the status of each risk (see figure 32 , in chapter 5), e.g. the date when the risk was raised as well as the date the risk has been excluded or changed. Continuously updating and reporting the progress of the implementation of each risk response action, checking its effectiveness in reducing or terminating the risk while simultaneously identifying new risks that stem from these actions (secondary risks). The ATOM methodology prescribes that for both simple and complex projects, there needs to be an independent "*risk champion*" who coordinates and oversees the implementation of PRM actions and continuously checks their progress and thereby keeps the risk register up to date (Hillson and Simon, 2007).

At HMC, there is no independent control or check of risk response implementation (interview 1, see appendix N). Neither is there a record of why risks have been closed, deleted, expired or perhaps actually occurred (see appendix M.3.7). Hence, it remains unknown if specific risk response actions have been implemented that reduced or changed the project's risk profile or that the risks simply changed because things turned out in favor of the project's objectives. This makes it impossible to distinguish between good luck/good management and bad luck/bad management. When one explicitly reports on these matters, it becomes possible to show the effectiveness of the PRM process and evaluate the choices that have been made in the face of uncertainty. Currently, the risk coordinator at HMC is responsible for facilitating the risk process, organizing risk workshops and developing the project's risk register. However, planning, implementing and monitoring risk responses fall all under the responsibility of the project's manager (HMC risk procedure, 2008). So the question remains, who checks what actually happens as a result of all the effort and time spent on identifying and analyzing the project's risks?

Research by Kutch and Hall among 19 project managers from 11 separate companies has shown that there are several reasons why risk management is ineffective when there is no external check or control. This stems from the fact that there are all kinds of barriers to taking preventive actions in the face of risk, which "*manifest themselves as conditions of denial, avoidance, delay and ignorance of uncertainty*" (Kutch and Hall, 2005). This implies that in some cases people consciously deny the very existence of risks. They refuse to reveal risk related information to their superiors or stakeholders, because they don't want to jeopardize a good relationship and being perceived as the "*doomsayer*". Thereby they cause a false sense of certainty that the project will eventually turn out to be successful. However while in fact the only way of achieving success is by removing the "taboo" on risks and create transparency and openness to address them effectively. In other cases, people simply avoid risks and their management because they have little confidence in risk estimates and as

a result can't agree on the best approach to manage risks. There might be all kinds of internal conflicts within a project's organization on who should take action and by what means, so that eventually the project's critical risks are avoided and nothing happens at all. Other common behavior that hampers effective PRM in practice stems from an overall lack of interest by the project's management, as each project manager has a different risk management preference or project management approach (Kutch and Hall, 2005). Consequently, this might result in a delay of effective risk implementation as actions are only taken in reaction to real issues, rather than that there is a constant focus on proactively managing risks and prevent issues from occurring in the first place. Finally, Kutch and Hall indicate that in some cases there is even a complete ignorance of uncertainty because there is just not enough time, effort and resources spent on managing project risks. Especially in complex, innovative and dynamic projects the effects of risks and uncertainty are often understated (see optimism bias in 6.2.3 8). This often results in failure to identify the need to check, report, collaborate and evaluate risks so that the project's risk register quickly becomes outdated.

In order to remove these "barriers" that hamper effective PRM, there needs to be a systems that explicitly checks risk management efforts to ensure they remain under control (Hillson and Simon, 2007). In fact, risk management is therefore more of a discipline than a tool, process or technique (Terry Cooke Davies, 2004). Effective risk management implementation requires learning new ways of thinking and then practicing them repeatedly until it is no longer an option, but a part of *"the way things are done around here"* (Murray-Webster and Simon, 2007). Currently, this is one of the major differences between the PRM process implemented at HMC and what is considered best practice PRM. As it can be concluded from the case study described in appendix M that the use of risk information to support HMC's decision-making still depends on the perspective, attitude and vision of the project's manager. Hence the possibility remains that the risk management process is applied with a *"tick-in-the-box"* mentality rather than that it drives all project decisions and activities. From reviewing the *"HMC project management manual"* it can be seen that all procedures and processes for management control are explicitly integrated along the entire project lifecycle. However there is no explicit reference within this manual on how the PRM process should be used to support decision-making within HMC. Hence, what is lacking is an open, clear and explicit system that encourages all team members and project stakeholders to review, comment and participate within the process.

6.6 Risk Reviews and Post-Project Evaluation – The project-lifecycle approach

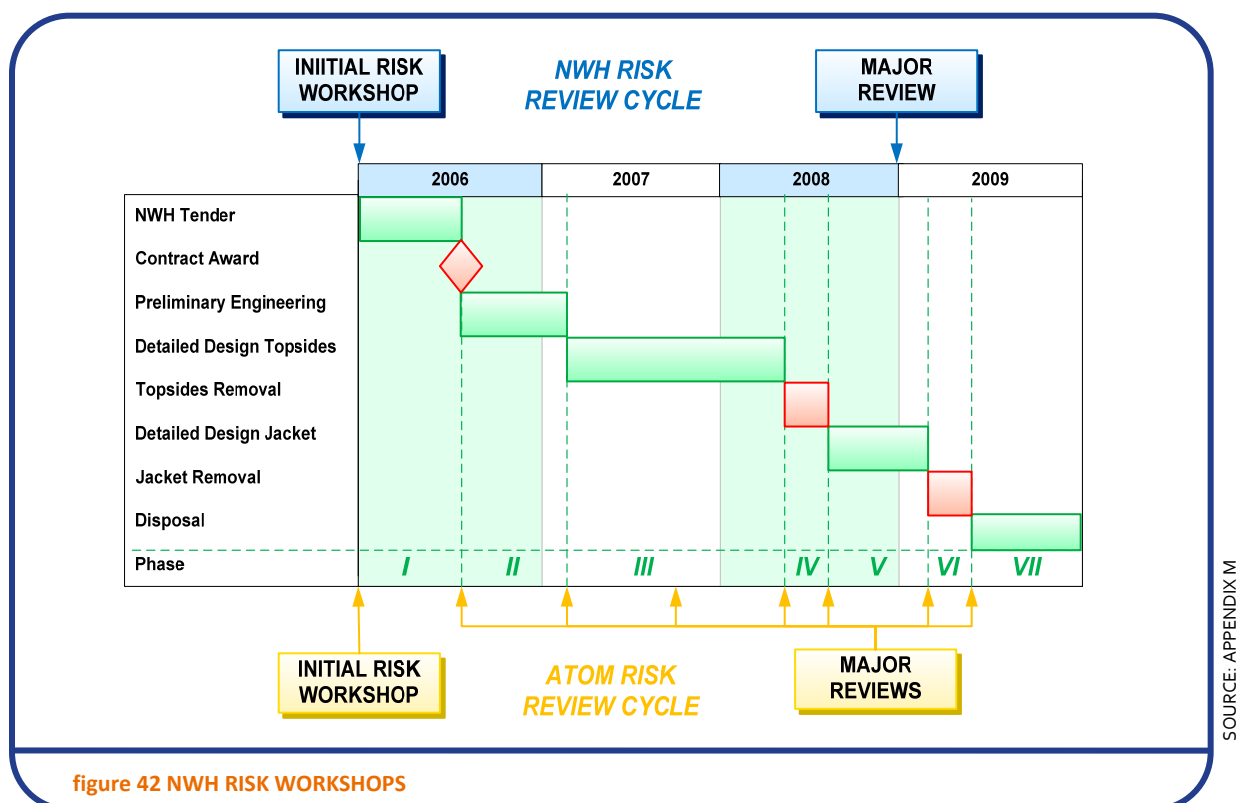
Up until this point, the HMC PRM process has been discussed from a mere static point of view, addressing the successive steps of RM planning, identification, analysis, treatment and implementation. However, as discussed in previous chapters, risk management is by any means a continuous process that takes place across the entire project lifecycle. Especially for large projects that involve substantial innovations, technical complexity and take place over longer durations, the level of risk constantly changes. It is therefore crucial to continuously review the process so that it is kept alive and changes are made when necessary.

6.6.1 Applying PRM continuously across the entire project lifecycle

The ATOM methodology of Hillson and Simon (2007) distinguishes among *major* and *minor reviews* of the project's risk profile and risk responses (see chapter 5). A major project review uses a single workshop to repeat all previous steps of the PRM process, providing a full reassessment of the project's risk profile. Hence, such a review should take place at key points in the project's lifecycle, for instance at the beginning of a new project phase or when there has been a significant change to the project's scope, schedule or methodology. Additionally, minor reviews take place in line with the normal reporting scheme of the project, taking place at regular intervals to assess the most important changes.

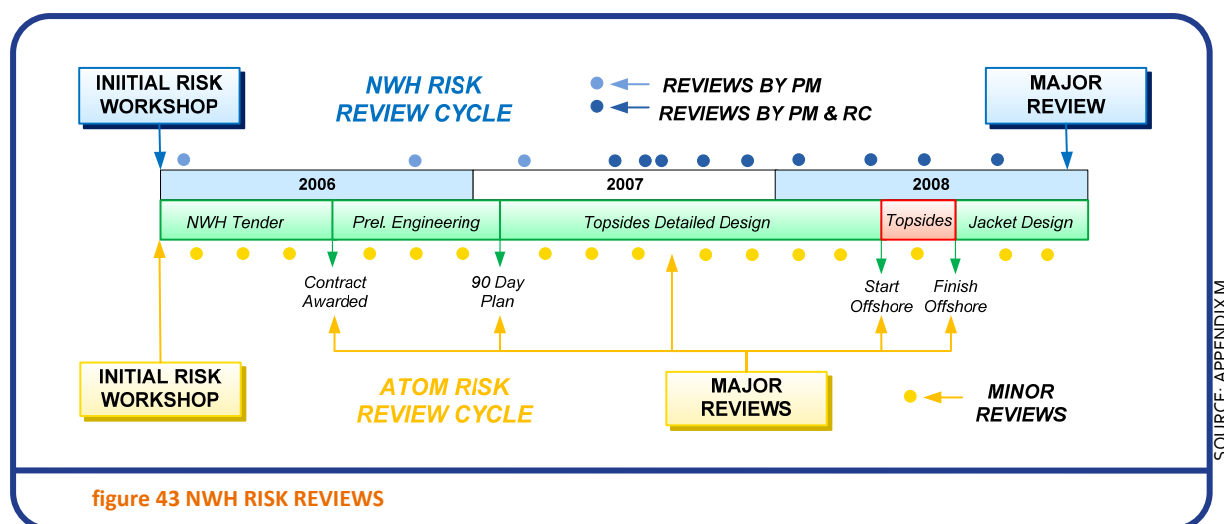
The HMC PRM process does not distinguish between major and minor reviews. Within each project, there are several risk workshops organized which can be seen as a major review of the project's risk profile. The initial risk workshop takes place in the *tender phase* of the project. Next, there is a second risk workshop during the *project phase*, when the eventual contract has been awarded to HMC. However this workshop is not a risk "review" meeting, because in fact the HMC risk process starts all over again (interview 1, see appendix N). Consequently there is no explicit review of the tender risk register to check which risks have been treated effectively (in the project schedule, budget and contract) and which still require a lot of attention during the project phase. For effective management it is important that the Project Manager and his team understands which assumptions, decisions, contingencies and plans have been made during the tender phase. This information forms the starting point for the management of risk during the successive phases of the project. Within HMC, this information should be handed-over in a specific project meeting between the Tender and Project Manager. However from the case study analysis it can be concluded that during this meeting there is no explicit check or review of the project's risk register (interview 2, 8, 10, 11 & 13, see appendix N). Hence, it might be the case that within the project's tender and bid it is assumed that a lot of risks will be managed by the project manager. While the project manager on his turn indicates that many plans are made without carefully incorporating the means and resources to address these risks.

HMC lacks an integrated PRM process across the entire project lifecycle (see appendix M.3.8). Because one might not only use a risk register for reporting on perceived project risks, but it may also function as a communication tool to coordinate the transfer of risk responsibility and focus from one phase to another. As can be seen from the analysis set out in chapter 4, there are several separate phases within the current EPRD projects in HMC's portfolio. At the start of each phase there is a change of the project's risk profile, which requires a major review of the risk register by all project stakeholders. From analyzing the NWH project, it can be seen that in practice there has only been a single risk review workshop in 2008, after the topsides had been removed (see figure 42).



Apart from a continuous and rigid review of the PRM process on critical milestones within each project, there are many regular updates of the risk register. At HMC, every two or three months, the Project Manager, Risk Coordinator and Cost Estimator step through the risk register to reassess, identify, and quantify all important risks so that the register remains up-to-date (see appendix M.3.8). However from case study interviews it can be concluded that before this explicit “review meeting”, many Project Managers discuss the project’s risks during the conventional project progress meetings with the project team (interview 2, 10 & 21, see appendix N). In these meetings, changes are discussed and recorded and likewise the risk information is communicated to the project’s sponsors and client in the monthly Project Status Report. So the actual review of the risk register is only partially integrated with the overall PRM process. While ideally, such a meeting should be facilitated by the project’s risk champion to explicitly record changes, new risks and to make sure that the risk register is correctly documented using the information of all risk owners within the project’s organization (Hillson and Simon, 2007).

A noticeable difference between the ATOM methodology and the HMC risk process is that HMC reviews the quantitative analysis of risk on a regular basis (see figure 43). During a risk update, the Project Manager reassesses the quantitative risk values in the risk register so the Monte Carlo model can produce an update of the overall risk profile of the project. However, the ATOM methodology prescribes that during a normal project risk review, focus should be on the status of current risks and the implementation of risk response actions, rather than devote attention to the complexity of the quantitative risk model. Because for effectively reviewing the quantitative model, one would require the input from all stakeholders to not only address changes to the project’s risks but also include the required updates to the model itself. Accordingly, it is more likely to reassess the quantitative model during a major review sessions at the start of each project phase when there is sufficient time to do so effectively. Minor review sessions need to be focused on discussing the effectiveness of risk responses in practice, rather than reassessing the quantitative risk level.



6.6.2 Post-Project Review – Learning from experience

The final step in the PRM process is about contributing to organizational learning on the subject of risk management. This means reviewing the project risk register and discussing the effectiveness of the PRM process in managing the actual risks within the project. A good post-project review is therefore an essential part of every risk process, making sure that there is continuous improvement and learning within the organization. The ATOM methodology states that it is not only important to discuss and review each project, but to make sure that there is a knowledge infrastructure to document and record experience from completed projects that can easily be used for future projects. Because what is the point in recording all kinds of data and information if it is never used?

At HMC, the post-project review is not explicitly part of the risk process, but takes place during the normal project management cycle (See appendix M.3.9). A meeting is held with all important project stakeholders to carefully review the project. From analyzing the NWH project, it can be seen that some part of the meeting focuses on the review of risks, however there is no explicit check of the risk register on which risks have occurred and how effective their mitigations were in practice. Furthermore, there is no review of the risk process itself, showing how many risks were deleted, closed, expired or occurred and if it was adequate for managing the specific project risk profile.

Failing to effectively grasp risk knowledge and use this for future project implies that over time, the same risks will affect future projects over and over again. While in most cases lessons learned are effectively implemented in the next project, but not necessarily on successive projects (Interview 11, see appendix N). This implies that it is likely that the same problems occur in the third or fourth project that were not foreseen or managed on the first projects. Hence a post-project review session should focus on both the negative and positive lessons learned; clearly showing which decisions and organizational conflicts caused the project's inherent failures and successes. To do so, a well documented risk register is essential, which shows which decisions were made to manage the risks, when and by whom. Currently, this is not clear in the HMC PRM process, making it very difficult to effectively track the sources of change that significantly altered the outcome of the project. Let alone what has been done to make the entire project more capable of handling such changes in the first place.

6.7 Summary and conclusions

Summarizing, there are a number of important differences between the HMC PRM process and the ATOM methodology (see figure 44), which is considered as the current best practice process for managing project risk (see chapter 5). The considerations set out in this chapter are the results of an intensive case study analysis of the entire risk management cycle, focusing on both qualitative and quantitative risk management techniques (see appendix M). Conclusions are made by comparing and mapping HMC's process, supported by specific HMC risk documents and interviews with key personnel from HMC's organization (see appendix N).

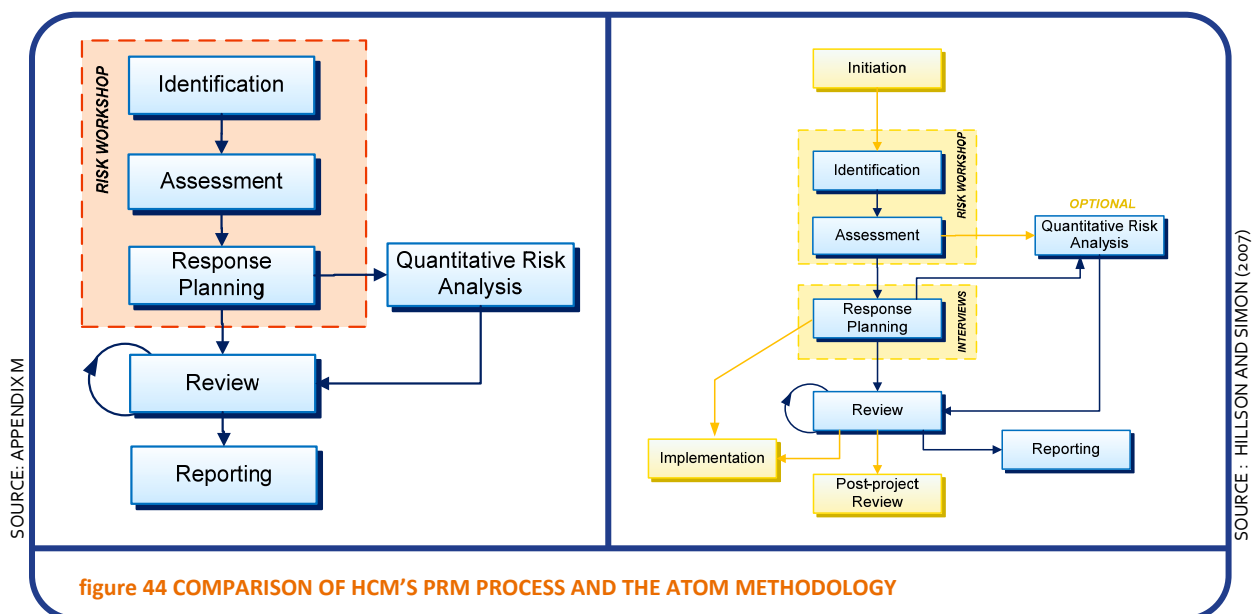
First of all, the case study analysis has shown that there is only little scalability in HMC's PRM procedure, while the ATOM methodology prescribes to develop a project specific approach. Chapter 4 has shown that because of differences between the more conventional T&I projects and complex EPRD projects, a different PRM approach is desired. HMC however uses the same risk procedure, risk tools, techniques, review cycle and quantitative model to all of its tenders and projects. This implies that for the more "simple" projects the process might be perceived as being "bureaucratic" or "boring", while for others far more resources, time, techniques and rigorous control is required to effectively manage the project's risks. Hence, what is missing is a specific initiation step in the PRM process, which focuses on determining the required level of risk management application that fits the perceived risk of the project. This ensures that all project stakeholders discuss and agree on how to manage project risks, resulting in a project-specific *Risk Management Plan*.

Secondly, there are many differences between the time, tools and techniques applied in HMC's risk workshop compared to what is considered best practice. The ATOM methodology gives that for large projects such a workshop may last for up to three days, while HMC applies a risk workshop that takes only three hours. Hence, there is a focus in the risk workshop on gathering as much risk information as possible, rather than ensuring that all the important project stakeholders discuss, agree and collaborate extensively on the project's risks to guarantee that the gathered information is of sufficient quality. Furthermore, one might use additional tools for the identification of risk in complex and innovative projects apart from the more common risk brainstorm. Project specific impact scales and risk factors for risk prioritization might increase the effectiveness of risk assessment during the

workshop. Currently, there is only little time during the HMC risk workshop for the rationalization, categorization and allocation of risks to ensure the process can effectively move to the next stage. If there is no clarity on who should take responsibility for the management of each identified risk, reality teaches us that in many cases nobody does. So a critical element of the risk workshop that is currently missing is the explicit allocation of each risk to a single individual that is considered the best risk owner.

Thirdly, the HMC PRM process applies quantitative risk analysis to all of its tenders and projects. However, there is no project specific model used for analysis, which reflects the network of subsystems and interactions that make up the project's design. There is no explicit distinction within the model between the analysis of "variability" to current plans and the actual existence of risk events that affect specific parts of the project. Accordingly, the quantitative model lacks sufficient detail to support effective risk analysis and generate valid results that can be used to support risk response planning. From the case study analysis, it can be seen that the model's results are rarely used in the decision-making process for setting the right amount of contingency in project budgets and schedules. Best practice PRM therefore prescribes to only apply quantitative risk analysis for projects that are large or highly risky, where the investment in such techniques can be justified. It requires a lot of effort to develop and update a valid risk model if one wants to generate project specific results that give a good representation of the perceived project risk profile.

Finally, a number of critical steps are missing that ensure that the PRM process moves from planning towards effective action in practice. Best practice PRM recognizes the need to explicitly allocate the responsibility for developing and implementing risk responses among the project's organization. This means rigorously reporting, monitoring and controlling the status of each risk and agreed actions treat the risk. Within HMC's current approach the project manager is the single person responsible for developing, implementing and controlling all responses to the project's risks, which in fact means that it remains unknown how risks are actually managed. There is no check within the current process to see if actions have been taken proactively. HMC's risk review sessions focus on "updating" the project risk register and risk model, rather than explicitly discussing why risks changed and which actions were implemented. Hence it is not possible to review the effectiveness of HMC's current approach, and gather important lessons for managing risk on future projects.



Chapter 7

*"If a man begins with certainties,
he shall end in doubt. But if he
will be content to begin with doubts,
he shall end in certainties."*

Francis Bacon

*"Everything should be made as simply
as possible, but not simpler."*

Albert Einstein

*"A pessimist sees the difficulty in every opportunity,
an optimist sees the opportunity in every difficulty"*

Sir Winston Churchill

**7.1 Quick Wins for
Improving HMC
PRM Process**

**7.2 Interactive evaluation
session with HMC
management**

7. How to improve PRM in complex EPRD projects



As the previous chapters of the thesis report focused on the exploration and analysis of the problem situation, this chapter describes the development of an approach for improving HMC's PRM process. As set out in chapter 3, the thesis focuses on generating solution-oriented knowledge by developing a tailored approach to improve the effectiveness of HMC's PRM practice in EPRD projects. Thereby research shifts from the "soft" interpretive paradigm to a more "hard" descriptive paradigm within this chapter, using findings from the literature review described in chapter 5 for the identification of possible improvement to HMC's current procedure. It should be noted that information presented in this chapter is the result of an iterative design cycle, using the considerations for improvement set out in chapter 6 as a starting point. Next, the specific risks of EPRD projects described in chapter 4 are contrasted with these findings to identify a number of "quick wins" for improvement. This chapter explicitly focuses on addressing the technical, organizational, and environmental complexity in EPRD projects that drives their heightened risk profile (see chapter 4). Accordingly, the following research questions will be discussed and answered:

4.1 How can the HMC risk management process be improved to cope with the complexity and risks in current and future EPRD projects?

4.2 Which recommendations can be made to improve the application and effectiveness of HMC's risk management process in EPRD projects?

Thus, there is no aim of completely redesigning HMC's risk management approach to best practice standards. Rather the "best practices" from literature provide a number of essential options to quickly enhance the effectiveness of HMC's current process. Therefore, this chapter provides a number of these "quick wins" that can easily be implemented in HMC's current procedure, focusing on the process's lay-out across the entire project lifecycle (e.g. from Tender to project Close-out) and the use of tools and techniques within this process.

First, a selection of eleven "quick wins" for improvement is discussed in the light of the analysis set out in chapters 4, 5 and 6. Specific issues and results from case study analysis are contrasted with best practice PRM literature for the identification of recommendations. Next, the results of an interactive evaluation session with HMC management are discussed. This workshop has been organized to evaluate the results of the thesis and to discuss the recommendations for improving HMC's PRM process to cope with risk in EPRD projects.

7.1 Eleven “Quick Wins” the improvement of HMC’s PRM process

For the development of recommendations to improve HMC’s current PRM process to better cope with the complexity and risks in EPRD projects, the considerations described in section 6.7 of the thesis report are used as a starting point. During the development-oriented phase, a vast array of possible improvements and changes to the current approach have been identified, of which the eleven most important will be discussed in the following section. Due to the large scope of the thesis project, it has been chosen to discuss each recommendation on a relatively high level of abstraction. This provides a complete overview for improving HMC’s PRM process across the entire project lifecycle, rather than specifically designing the tools and techniques of a single step within the process to the upmost detail. Hence, the recommendations provide guidance on where HMC should focus its efforts, rather than providing a completely worked out PRM manual which can be implemented directly.

7.1.1 QW1: *Develop a project specific Risk Management Plan*

One of the most important elements of an effective PRM process is that it is scalable, making it possible to vary the required approach to fit the perceived level of risk within the project (Hillson and Simon, 2007). As discussed in section 4.2, all projects are risky; hence everyone agrees that managing risk is a core part of project management. However some projects are riskier than others, depending on their size, scope, complexity, innovativeness, environment etc. Accordingly, there is a lot of different ways and levels of PRM implementation and in order to be effective, the chosen approach, tools and techniques should correspond with the project’s risk profile. Hence, the PRM process should always start with an explicit “initiation” step in which it is determined to what level the risk management process should be applied, while at the same time retaining a common risk methodology.

As can be concluded from the results of the case study analysis described in chapter 4, HMC has started to broaden their project portfolio from the conventional installation projects (over 50 years of experience) towards the more complex and riskier deepwater pipe-lay, EPIC and EPRD projects. As section 4.2 highlighted, there is a clear difference between the more conventional installations and current EPRD projects due to an overall lack of experience and a difference focus of the client. The heightened risk profile of removal projects compared to installations makes it more difficult and risky to commit to a predefined project budget and delivery schedule. In addition, the increased scope, uncertainty and dynamics of EPRD projects add to the project’s risk profile. And while a risk taking attitude and a just-in-time way of working may be essential for success in the regularly performed installation projects, it may work against one in a large-scale removal project (see chapter 4).

Consequently, it is no longer possible for HMC to use a standard PRM procedure to all of their projects. Because such a process will be perceived time-consuming and bureaucratic in the conventional installation jobs in which HMC has a lot of experience, but is totally inadequate for the large and complex EPRD projects that are novel to the entire industry. As can be concluded from the analysis in chapter 6, there is only little variation to HMC’s current approach and the absence of an explicit initiation step at the process’s kick-off. HMC develops a specific Execution, Cost, Document, Interface, Quality, Safety, Operational etc. Plan, it is recommended to also develop a project-specific *Risk Management Plan*. Such a plan clearly describes the scope, level, objectives and focus of the PRM process applied to each project. It is desired to vary the amount of tools, techniques, reviews, reporting requirements etc. that are used to ensure the implemented process fits the risk challenge of the project.

The heightened risk profile of current and future EPRD projects requires an extensive and explicit risk management process, applied with sufficient rigor and discipline to ensure its effectiveness in practice (see chapter 4). However there are still many factors that might contribute to deciding on the appropriate level of PRM for any particular EPRD project. Some examples are:

- **Number of platforms that have to be removed** (single removal or a total removal package)
- **Size and scope of required removal** (Total platform size, location and design, type, state, integrity)
- **Overall project value** (small or large value of the project compared to HMC's project portfolio)
- **Removal legislation and local content** (highly regulated or novel sector concerned offshore removals)
- **Experience with project's client and subcontractors** (common parties or new relationships)
- **Project's duration and offshore scope** (single offshore campaign, or project duration of several years)
- **Commercial and contractual complexity** (type of contract, specific client requirements, LOI specifics)
- **Technical complexity** (common approach or development of innovative concepts, tools and methods)
- **Organizational complexity** (Number of teams, subcontractors, conflicting interests, interfaces)
- **Requirement stability** (interference of client, elements that are subject to negotiation)

This means that there exists no single approach that will fit all EPRD projects. Hence it is recommended to hold a specific risk initiation meeting with key project stakeholders to define the appropriate level of risk management to be applied within a particular project. Such a meeting should take place in both the Tender as Project phase of the project within overall project management process. Within the Tender, the meeting might be held *internally* with the project's Tender Manager, Leadership Team, Risk Coordinator and the designated Project Manager. Such a meeting should focus on the general risk profile of the project and its importance to the strategic objectives of HMC, lasting for about half a day. The meeting should identify the best way to set the project's budget, schedule and contract in the face of the perceived risks and uncertainty. Hence, it might be decided to use quantitative risk analysis techniques to evaluate the project's plan and determine a sufficient amount of contingency fund in the initial tender bid. Furthermore it might be decided to include specific resources within the contract for the explicit management of risks, like for instance a full-time project risk champion.

Next, if the project is awarded and the contract is signed with both client and subcontractors a second initiation meeting is desired. This forms the start of the PRM process with all important stakeholders, e.g. an *external meeting* to which the client, experts, HMC personnel and subcontractor representatives are present. This meeting may last for about half a day as well, or it might be integrated with the project's kick-off meeting. Within this meeting, it is important to agree with all important parties on the *project's objectives* and the required *level of risk management* implementation. It should be decided which tools and techniques will be used during the risk workshop, how many of these workshops and review meetings will be organized and when there will be major risk reviews required throughout the project's lifecycle. It is also important to determine specific project PI-scales, a RBS structure and reporting requirements as well as to clarify the roles and responsibilities of everyone within the project's organization. Accordingly, these decisions should be carefully documented in the project's *Tender Risk Management Plan* and *Project Risk Management Plan* that might contain the following elements (Adopted from Hillson and Simon, 2007):

- **Scope and objectives of risk management process** (Including of subcontractor risks, supplier risks etc.)
- **Degree of risk management implementation** (quantitative analysis, risk champion, use of risk info)
- **Risk tools & techniques in risk workshop** (review of past projects, expert consultation, SWOT analysis)
- **Planned risk management activities** (major reviews, quantitative updates, risk workshops)
- **Roles and responsibilities for risk management** (sponsor, manager, risk champion, risk owners etc.)
- **Reporting and review requirements** (risk report, risk registers, risk in PSR meetings)
- **Project specific PI scales for qualitative assessment** (PI scales, project RBS, risk thresholds)

7.1.2 QW2: Perform an explicit stakeholder analysis

The second “quick win” to improve HMC’s PRM process is to include an explicit stakeholder analysis in both the Tender and Project risk management process. For conventional projects where HMC is one of the project’s subcontractors such an analysis is mostly performed in an implicit manner as most risks stem from HMC’s internal organization. However as can be seen from the case study analysis set out in chapter 4, HMC takes on a different role in EPRD projects. HMC is no longer the project’s subcontractor for the offshore lifting and transport operations, but takes on the role of main contractor and thereby the responsibility for coordinating other parties along the entire supply chain. Thus, HMC should not only manage their own risks but also those of their subcontractors and their subsequent interfaces. From the case study analysis, it can be concluded that approximately 25% of the project’s risks stem from HMC’s subcontractors in current EPRD projects. It is therefore recommended to perform a specific risk analysis during the Tender phase on the perceived subcontractor risks and their importance to HMC’s objectives. Because in an EPRD project, it is not possible to simply transfer or offload a part of the project’s risk profile to a subcontractor if HMC is still held responsible for the overall project outcome. Hence, it is desired to evaluate subcontractors not only on their relative costs and bid information, but also on their potential risk to the project as a whole. Some subcontractors might be cheap, but because of the uncertainty they add to the entire project it might be a more “risk efficient” choice to pay somewhat more for a party that is known to execute the job effectively. Hence it is essential in EPRD projects to evaluate and understand the relative subcontractor risks during the Tender phase of the project, for which the results can be used during the *Procurement Board Meeting* to support decision-making. According to the perceived risk profile of each subcontractor, it can be decided to include specific measures and incentives for risk control, and pose specific requirements to select a certain subcontractor.

Next, when the project is awarded it is recommended to perform an explicit stakeholder analysis at the start of the PRM process. This will determine which internal and external stakeholders affect the project and assess them on their *attitude towards* the project (supportive or resistant), their *power to influence* the project and their *level of interest* in the project’s outcome (Hillson and Simon, 2007). As can be seen from section 4.2, there is different level of interest and attitude of the client towards installation than towards removals. As removals are cost-driven, it is likely that the client will try to transfer as much risk as possible to the contractor. However the focus on a safe and sound project execution to protect the client’s reputation might imply additional requirements and offshore delays, providing additional risk to the project as a whole. This is especially important because the platform’s safety case still falls under the control of the platform’s operator during the entire removal operation. This gives important implications when making decisions on the appropriate contract structure and required PRM activities throughout the project’s lifecycle. Furthermore, it should be clear which other parties outside of the project might intervene and add additional complexity to the entire operation. As described in section 4.4.3, there is a lot of public attention on the removal of large installations. So for every large EPRD project there is always an extensive interaction with local governments and other parties that causes environmental complexity. Newly build disposal yards will cause additional risk, as local parties may hamper the process of acquiring all the necessary permits for the transportation and disposal of hazardous materials. This clearly stresses the importance of an explicit stakeholder analysis in the beginning of each EPRD project to map all parties and their interest towards the project. It is necessary to decide which parties should be included in the formal risk process and which other parties might be consulted on their respective interest, opinion and power to affect the project’s outcome.

Especially with EPRD projects, the client and subcontractors should be included within the risk process to create clarity, openness and transparency on the project’s risks and the management thereof. This ensures that there is a cooperative strategy to address these risks pro-actively; instead of leaving those somewhere in the middle which might cause each party to blame one and another when problems start occurring. This often results in annoying conflicts, disputes and massive legal claims that only further increase the risk level of the project as a whole.

7.1.3 QW3: *Change Risk Workshop set-up*

The importance of the risk workshop cannot be underestimated, because “*failing to identify a risk means taking it with your eyes closed*” (Hillson and Simon, 2007). However for such a workshop to be effective it should be carefully prepared and facilitated to make sure that all the required elements receive the necessary attention. Risk identification and assessment requires sufficient effort and openness from all project stakeholders, to be familiar with the tools and techniques and to have the right information on the project’s scope and objectives. This again emphasizes the importance of the risk initiation step, as one can never identify risks effectively without clear project objectives and agreement on the scope of the PRM process. The analysis set out in chapter 6 gives a number of concrete recommendations to improve the effectiveness of HMC’s risk workshop:

Increase the Risk Workshop’s duration from 1-3 hours to 1-2 days

As many recognize that the risk workshop is the prime enabler of any risk management process, such a workshop is often perceived as time consuming, ineffective and “boring”. Consequently, HMC has chosen a new approach in 2006 to drastically reduce the time for such a workshop from a couple of days to only a few hours and to focus on quickly and effectively gathering all the required information in a single effort. This might be an effective approach for the more common and non-complex projects, however it is almost impossible to effectively identify and assess all project risks for a highly innovative and complex EPRD projects in only a few hours. Hence, it is recommended to increase the workshop’s duration for EPRD projects to last for up to two days, making sure that the workshop contains all the necessary elements for the identification of project risks, and allow enough time for collaboration and a fruitful discussion among project stakeholders to agree on these risks and their importance.

Make sure all stakeholders attend the risk workshop – Include offshore crew and Subcontractors

One of the important elements of a risk workshop is that all key project stakeholders ought to be present. Hence for a Tender Workshop, it is recommended to include the designated *Project Manager and Project Engineer* to give their input and experience on risks that were not properly handled in previous contracts or plans (or provide important opportunities to increase project value). In this way the eventual Project Manager understands how the project’s Business Case is put together and how it links to the preparation of the plans for which he is responsible. And like no other, a Project Manager can provide valuable risk information to the project’s Tender Manager on the various elements that cause risk in current EPRD projects.

Next, it can be concluded from the case study that offshore personnel rarely attends the project’s risk workshops. While in fact, they are the ones that have the practical knowledge and experience on the project’s operational risks, which form an essential part of the risk within all of HMC’s projects. Especially in the early phases of an EPRD project, there is still a lot of uncertainty on the most cost-efficient removal method. It is therefore recommended to explicitly include operational personnel (*superintendent*) to every risk workshop, ensuring their participation in the project’s front-end development. However as discussed in chapter 6, this might be difficult because the offshore crew is working on the SSCV and does not have the time to frequently come to HMC’s main office, especially when these workshops may last for over two days and require a frequent review. One way to overcome this issue is to make use of *virtual meetings*; perhaps using one of the new web-based meeting tools to make sure the offshore crew is included in the project’s risk workshop. Moreover, since the beginning of 2009 there is *permanent field engineer* present in HMC’s office to provide practical input for the project’s engineers. Hence, it is essential that these field engineers also attend the project’s risk workshops in EPRD projects. Next, it is recommended to include important *subcontractors*. As HMC is responsible for the management of the entire project, the project’s risk profile can only be managed effectively if subcontractor risks are included, as within EPRD projects the subcontractors hold a large part of the overall project risk profile for HMC. If critical stakeholders are absent to the workshop, it is recommended to explicitly interview these parties to gather their input at another moment in time to make sure that any additional risks are included.

Carrying out pre-workshop activities to increase workshop effectiveness

Because it can be very hard to organize a risk meeting where all the relevant project stakeholders are present, one should make sure that the time within this workshop is primarily used for risk identification and assessment. To increase the effective use of valuable workshop time, it is recommended to provide attendees with some *preliminary reading* on the project's business case and scope, making sure that people can already prepare themselves for the workshop, which allows getting off to a flying start. In addition, you might want to ask attendees to consider the *sources of uncertainty* (cause of risks) that are concerning them the most at the moment, or to identify *five threats and five opportunities before attendance*. It is important to indicate the focus on both an equal number of threats and opportunities, as the risk workshop should address both upside and downside risk. This ensures that in advance, people have already thought about some important opportunities that can be included in the risk register. It can be seen from the case study that when people start to think negatively about risk, it is very hard to switch back to the positive perception of risk, as we naturally associate risk with a threat or hazard. Hence, many risk workshops fail to identify a significant amount of opportunities.

Include Added Value Session in Risk Workshop

Another way to improve this notion is to explicitly start with the identification of opportunities, asking people to view the project through "*rose-tinted*" glasses. Next, a separate session may be held that explicitly focuses on threats. It is very difficult to identify both in a *single brainstorm*, but more effective to use a *single risk workshop* to identify both. It is therefore recommended to include the recently developed "*added value sessions*" at HMC in the risk workshop's set-up. During the case interviews, it was argued that these value sessions are rarely used, and that the information gathered is not explicitly linked with the risk management process (see chapter 6). Including a specific "*opportunity brainstorm*" or "*added value identification*" element in the current risk workshops allows the effective identification of both threats and opportunities. This ensures that both are managed proactively through the same PRM process, system and documents.

Include explicit risk categorization step in Risk Workshop – Structuring Risk Information

Currently, there is no specific categorization of risks according to their source or perceived effect during HMC's risk workshop. A certain structure is used during the risk brainstorm to temporarily group risks, but this information is not recorded on the risk input sheets. Therefore it remains unclear if a risk applies to the entire project or to a specific phase within the project. Neither is it clear which element(s) is perceived as the risk's main cause. Hence it is recommended to explicitly structure the identified risks, mapping them to both the project WBS (Work Breakdown Structure) and RBS (Risk Breakdown Structure). Effectively structuring risks creates insight into the amount of positive risks compared to negative risks (separate and compare opportunities and threats) and to identify specific hotspots or focus areas within the project. Moreover, it becomes easier to take out risk duplicates, rationalize on the perceived sources of risk within the project and to effectively assign risks to the people that should be responsible for their management. Examples of risk mapping and structuring can be found in appendix M.3.3, as well as a common RBS structure in appendix I.1.4.

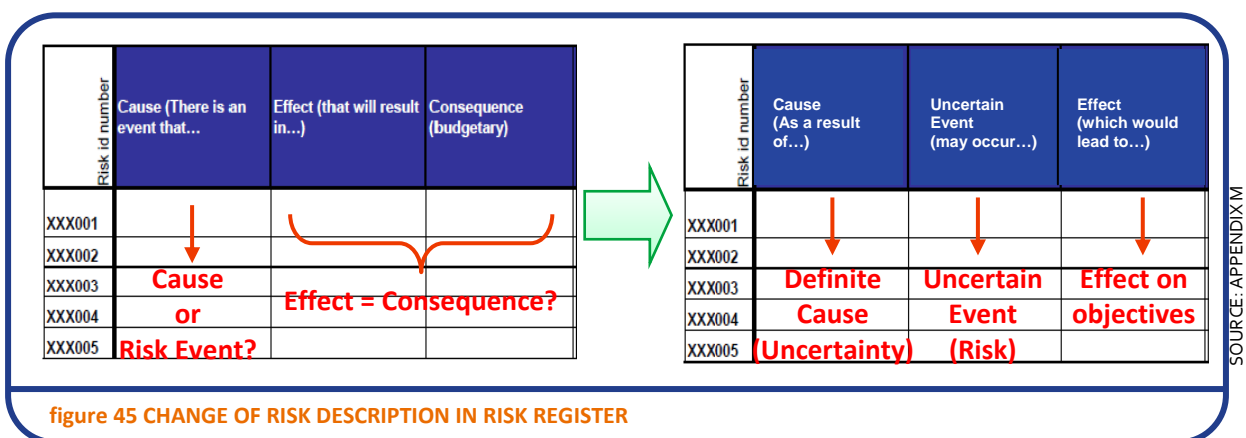
Explicitly nominate individual risk owners

The final element of an effective risk workshop is to ensure that all parties agree on who is best placed to manage a certain risk. As it is very likely that those people are also present at the risk workshop, it is recommended to discuss the list of risks and allocate risk responsibility to those people in the organization that have the right knowledge, experience and responsibilities to take action. It is crucial to notify a single risk owner for every risk, as there can only be one person responsible for taking a decision on the required approach (in collaboration with others). In the current HMC risk process, risks are in many cases assigned to a group of people which eventually implies that nobody takes responsibility or action. Moreover, the tendency to push risks towards the Project Manager should be avoided, unless he truly is the person best placed to manage the risk.

7.1.4 QW4: Use meta-language for risks that clearly separates cause, event and effect

For any PRM management process to be effective, it is crucial to separate risk from uncertainty, clearly describing each risk in a three-part structure that separates its cause, the uncertain event itself and the effect on objectives. Currently, there is no clear distinction between risk and uncertainty in HMC's definition of risk. As can be seen in table 12 of section 6.3.1, it is often not clear what the source is of many of the identified risks. This makes it far more difficult to develop effective risk response plans, as most risk response actions should focus on addressing the source of a given risk. Correctly describing risks as uncertain events with a certain cause and effect is therefore crucial to create determine if it is possible to change the source of the risk (by implementing proactive responses) or if one needs to add a specific contingency to the project's planning or budgets to cope with the risk's effects. It is therefore recommended to change the risk register and risk input sheets to contain the following description (see figure 45):

- “As a result of <1. definite cause>, <2. uncertain event> may occur, which would lead to <3. effect on objective(s)>.”



7.1.5 QW5: Change use of tools and techniques in risk workshop

As HMC recognizes the importance of an explicit Risk Workshop for the identification of project risks, it is essential that such a workshop makes effective use of tools and techniques to gather the right information for the eventual management of project risk. As risk workshops that result in poor risk descriptions, random assessment of probability and impact, meaningless prioritization and no time for thinking through response and contingency plans may well be a complete waste of time and money (Murray-Webster and Simon, 2007). Accordingly, best practice PRM prescribes to use project specific tools and techniques to increase a workshop's effectiveness, as well as varying common practices in order to inspire participants rather than bore them to death. It is therefore essential that every workshop is facilitated by an experienced risk coordinator that is familiar with a variety of creative and innovative techniques to identify and assess risks, thereby ensuring that people remain inspired and exiting about taking part in a risk workshop. After all managing risks should be fun and requires open and creative minds rather than a “tick-in-the-box” attitude.

Currently, HMC applies the same tools and techniques to all of their projects and tenders. For some projects a simple brainstorm may be sufficient for the identification of risks, while for more innovative and complex projects one might use several techniques to stimulate creativity and outrageous ideas (see scalability of risk process in section 7.1.1). Furthermore, the scales that HMC applies for risk prioritization are not specified enough to ensure a good qualitative assessment. As workshop attendants indicate that it remains unclear what is meant with the terms “low” or “high” and if one should consider the impact against the whole project or just against the schedule, scope, cost or quality (Interview 1, 6 & 12, see appendix N). As there are many techniques available for the identification of risks, it is up to the risk coordinator (responsible for facilitation of the risk

workshops) to vary the approach and select appropriate techniques that fit the project's risk profile. This thesis will provide some valuable additions to the current HMC workshop that are of a particular interest to HMC in current EPRD projects. Two important issues that were identified from the case study analysis are discussed, how to stimulate "out-of-the-box" thinking (interview 2, see appendix N) and the difficulty to assess a risk on purely qualitative P&I-scales.

Apply a variety of techniques for the identification of risk in EPRD projects

Currently, HMC applies a single technique for risk identification, e.g. a phased brainstorm. Splitting the brainstorm session in an individual, a small group and a full group sharing part may improve its efficiency in generating a large amount of ideas. At the same time it makes sure that everybody gets an equal say, as there are always people who like to hear themselves talk a lot and tend to control the meeting. However as discussed in section 6.3.1., there is also a downside to using a phased brainstorm. There is a high chance that people identify the same risks but write them down somewhat differently. Hence, a lot of time is spent on discussing which risks are duplicates and should therefore be excluded. For an effective brainstorm, there should be no criticism of ideas and an opportunity to build on each other's ideas. People should be stimulated and triggered by each other to start thinking out of their normal discipline and thereby identify important risks that would otherwise have been overlooked. It is recommended to clearly separate the identification of risks and the discussion and rationalization of risks. This ensures that the process remains creative and people stimulate each other during risk identification. Furthermore it is recommended to use a *Risk Breakdown Structure* (RBS), both to trigger people during the brainstorm and also to ensure completeness. During the second phase (small group sharing), people can step through the project's RBS and WBS structures to come up with additional risks that lay outside of their specific professions or scope. An example RBS structure is shown in appendix I.1.4 (one might include an example of an opportunity and threat for each of the RBS elements for clarification).

Next, there are a number of additional techniques that can be used to further stimulate out-of-the-box thinking. Best PRM recommends using a variety of tools for complex and innovative projects to stimulate the identification of additional risks next to a common brainstorm. For EPRD projects, it is recommended to use the following additional techniques:

- **Assumptions and constraints analysis:** Discussing the statements and assumptions that were taken for granted as "fact" upon which the project was justified and is being planned. This requires a specific evaluation of the *Tender risk register*, which should clearly indicate how the initial risks and uncertainties identified have been addressed in the project plan. Thereby the explicit and implicit assumptions and constraints that make up the project's boundaries are critically questioned. As especially with large EPRD projects, the conceptual plan might include a lot of uncertainty which offers both threats and opportunities to the project's outcome. Hence, these need to be reviewed explicitly when the contract has been awarded to HMC, as there might be a lot of optimistic assumptions in the bid in order to acquire the project, while these need to be addressed proactively in the project phase.
- **Standard risk checklist:** From reviewing comparable projects and lessons learned documents it is possible to generate a standard risk checklist. Clearly specify which "risks" occurred on previous projects and discuss these with the workshop attendants if there is a possibility that those risks will also affect the project under discussion. One might use a specifically developed checklist for EPRD projects or a common checklist that applies to all of HMC' projects. Some organizations have developed a specific risk database to capture risk information of past projects in an organized manner, making it very easy to quickly develop a specific project risk checklist that can be used for risk identification. Concerning the innovativeness of the project, it might be decided to specifically review past projects and interview key people within the organization to develop such a checklist in advance.
- **SWOT analysis:** Especially when performing an innovative project in which a lot of elements are new to the entire organization, it is very helpful to do a SWOT analysis to identify additional risks. Discuss organizational strengths and common weaknesses that relate to the project and the elements that are new to the organization, giving rise to additional risks that ought to be included.

Make use of project specific PI scales

Currently, the HMC process uses the same P&I scales for all of their projects (see table 16). However it is often not clear what is meant with “high” or “low” impact and if people consider the impact on a specific activity, project phase or the project as a whole. Hence, it is recommended to use project specific P&I scales to increase the effectiveness of assessing risk during the Risk Workshop. During the risk process’ “initiation” meeting, the project’s stakeholders should determine the scope of the risk process and what is considered to be a “Very High” time risk (e.g. 1 extra SSCV day or an entire week) and what is considered a “Very Low” time risk. The same can be done for other important project objectives like quality, engineering hours, cost etc. Next, it is possible to calculate the specific qualitative scales for each of the project’s objectives. This creates a specific scale for assessing the impact on the project’s schedule, budget, scope and quality items. Because currently it is not clear if a risk only has an impact on the project’s offshore duration (and therefore increases the project cost) or if there are actual additional costs that were not foreseen and have to be included in the project’s CBS. These distinctions are essential for effective response planning, addressing both the perceived risk causes and effects. Furthermore, HMC’s probability scales are focused on the past rather than the future. People naturally start referring to a known past (Cooke-Davies, 2005), this increases the likelihood that a risk gets a high probability and impact because it has occurred recently. In fact the question should be: What is the perceived chance that it will happen on the project under discussion?

Next, it is recommended to disassociate the assessment of probability from impact as people are naturally biased to link the two in practice. This can be done by splitting a group in two and ask if one half assesses probability and the other assesses impact. Or one might decide to first look at probability and then hide these results and focus on a risk’s impact. This removes any subconscious estimating bias relating to a risk’s probability and impact as much as possible. For an EPRD project, the following PI scales might be used (see table 16):

table 16 HMC: General Scale

SCALE	PROB	IMPACT
VHI	~50%	5
HI	~10%	4
MED	~5%	3
LO	~1%	2
VLO	~0,5%	1
NIL	~0,2%	0



Specific PI Scales (from Hillson and Simon, 2007)

SCALE	PROB	SCHEDULE	COST	MANHOURS
VHI	71-99%	>20 days	>\$200 K	Etc.
HI	51-70%	11-20 days	\$101K-200K	...
MED	31-50%	4-10 days	\$51K-100K	
LO	11-30%	1-3 days	\$10K-50K	
VLO	1-10%	< 1 day	<\$10K	
NIL	<1%	No change	No change	

Next, it is recommended to use additional factors to assess risks on their relative importance, such as the perceived strategic impact, manageability and the time window to take action. Especially with large EPRD projects that span over a couple of years, there may be risks that require immediate attention while others might be addressed at a later time. Risk sessions of over two days might identify hundreds of different risks. Hence, it is also important to consider the manageability of each of these risks. *Medium risks* that can easily be managed might be prioritized above *high risks* that cannot be influenced at all, thereby creating additional knowledge for the prioritization of risks and increase the effectiveness of risk responses in practice.

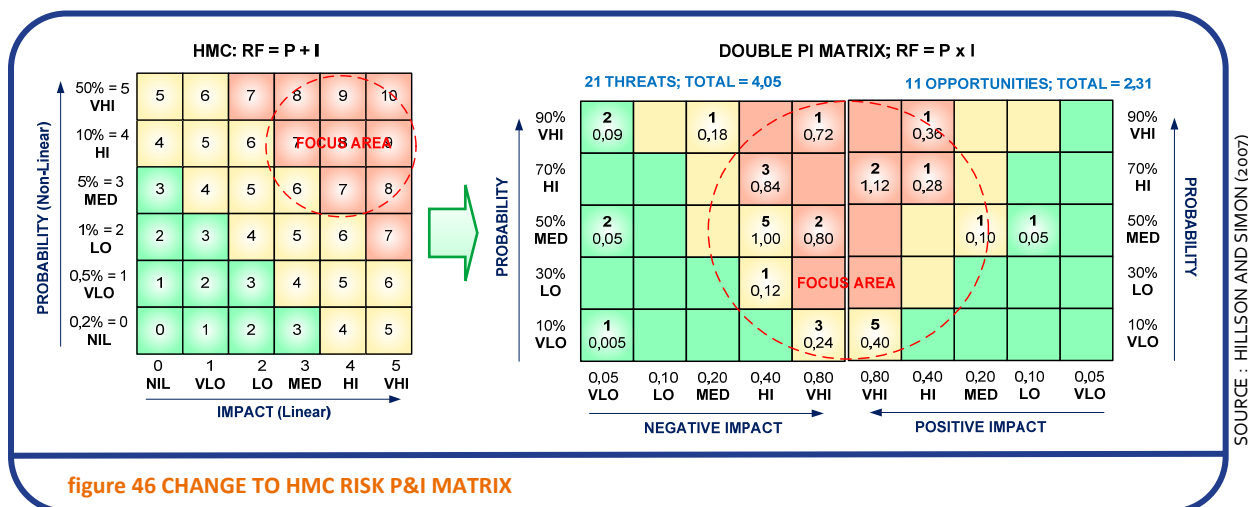
- **Strategic Impact:** Effects of risks on aspects outside of the project, relating to other projects, a higher-level program, common business activities or even the wider organization
- **Manageability:** The degree of ease to which risks can be managed, ranging from unmanageable to controllable by normal activities
- **Impact window:** When the risk impact might occur, indicating that risks that could happen soon should receive a higher prioritization than those in later phases of the project
- **Action window:** The period of time that is available to take effective action.

Accentuate impact over probability and use a quantified double PI matrix for prioritization

It is recommended to use a risk matrix for the prioritization of threats and opportunities, using specific “risk factors” to categorize in different groups of priority; e.g. “red risks”, “amber risks” and “green risks”. HMC currently applies a 6x6 risk matrix with a linear scale for both probability and impact (see figure 37), calculating the perceived risk factor (relative importance) by *adding* the assessed impact and probability; **Risk Factor = Probability (1-5) + Impact (1-5)**.

However as can be concluded from the analysis set out in section 6.3.2, current “best practice” prescribes to use a *linear scale* for probability and a *logarithmic scale* for impact in order to accentuate impact over probability. As one should be more worried about something that will “kill” but is very unlikely to happen than something that is almost certain but might only cause a little scratch. Hence, when jumping out of an airplane you should always bring a “backup” parachute that can bring you safely to the ground if the first one fails, while it might be less important that you will have to pack for all kinds of bandages because you might scratch your hand during the landing. Furthermore one should recognize the existence of “black swan risks” which are the highly unlikely risks that can have a devastating impact on the project (see figure 46)

Additionally, it is recommended to *multiply* probability and impact to indicate the difference between individual cells of the risk matrix, as a risk’s severity is often calculated by its probability times the impact on objectives. **Risk Factor = Probability (%) x Impact (0-1)**. Next, it is recommended to create an overview of the identified risks in a *double PI matrix*, clearly separating the number of threats and opportunity impacts. In this way it becomes clear how these relates to one and another and thereby provide the total spread of uncertainty (risk profile), giving a valuable overview of the qualitative risk assessment.



7.1.6 QW6: Use Pertmaster Software for Quantitative Analysis on specific project schedule

For an offshore marine contractor like HMC, business success depends for a large part on the effective estimation of project costs and duration. Especially because the industry is used to large lump sum contracts, HMC needs to carefully analyze the project’s risk profile in a quantitative matter in order to create a better understanding of the overall financial uncertainty associated with each project in advance. As can be seen from the analysis set out in section 4.2, there is a difference between installations and removals that clearly indicates the importance of using quantitative risk analysis techniques. Because of the fact that removal projects are cost-driven, it is more likely that the client will try to shift as much risk as possible to the contractor. With installations, a poor definition of the project’s scope can be in favor of HMC. Because HMC can more easily get extra revenues for the “additional work”, if it can assure the platform is installed on time. However with removals, the additional scope of work provides a threat to success of the project as the client is less interested in the project becoming delayed. So as HMC takes on the full responsibility of removing

the platform as a whole, surprises are no longer in favor of HMC, but quickly evaporate the already small margins. This clearly illustrates the importance of quantitative risk analysis in large EPRD projects, in order to proactively analyze the project's risks and provide enough contingencies in the budget and flexibility in the project's schedule.

Moreover, the relevance of quantitative techniques to HMC is stressed by the main cost driver of all projects: their offshore duration (see appendix L). The high costs of the SSCV explains the company's determinate focus on reducing the offshore time as much as possible and setting challenging targets to make best use of their largest asset. Hence, the optimization and analysis of the offshore project schedule is essential to create a good estimate of the total cost profile of the project. Consequently, quantitative risk analysis is considered to be a powerful and important tool for HMC, as it assists in making realistic budget/schedules and setting the right amount of contingencies during a Tender. Furthermore, it gives the opportunity to compare different project alternatives in the face of risk, allowing a cost-effective decision-making.

It should be noted that quantitative analysis is considered to be an *additional tool* to provide a *better understanding* of the project's risk profile, and can only be performed effectively if there exists an effective qualitative PRM process within the organization. Moreover, the development of a specific quantitative risk analysis model requires a lot of effort and company resources, and should therefore only be used when the costs can be justified in compliance with the perceived complexity and uncertainty within project plans. For EPRD projects, it is recommended to use quantitative risk analysis during the Tender phase to estimate the required amount of contingency budget, or the amount of "*profit @ risk*" (see figure 41, section 6.4.3). This will give a realistic estimate of the probability that the project will turn out better or worse than the initial estimate and tender bid. Based on the model's outputs, HMC's management can make an informed decision on whether to bid, at what price and with what contingency.

Next, quantitative analysis can be used during the project phase to test the feasibility of initial plans, and use risk information to make these plans more flexible or robust. This creates insight in the main risk drivers as well an understanding of how risks from one area can affect other elements in a complex project. The many interrelated subsystems and parallel paths in EPRD projects (see chapter 4) implies that a small risk can have a major effect on project objectives.

A number of recommendations are given that might quickly improve HMC's current approach for quantitative risk analysis. However, for an effective and valid analysis, many additional steps and elements are required that needs to be fully integrated with the overall PRM process. This thesis mainly focuses on the qualitative management of risk, and the steps and elements that are required to ensure and improve the effectiveness of such a process in practice. Hence, quantitative analysis is only partly discussed in this thesis. However, from the previous sections and the analysis set out in this report it can be concluded that it is worthwhile to investigate quantitative analysis methods into more detail, to improve the management of risk at HMC. It is recommended to:

Develop a project-specific risk model

As can be concluded from the analysis set out in section 6.4.1, HMC currently applies a common Monte Carlo model to all of their projects that uses an Excel-spreadsheet for the calculation of the project's overall risk profile. However to create a valid understanding of how risk spread through the project's network structure, offshore planning and dependencies among all kinds of integrated subsystems, one should use a project specific risk model.

Thus it is recommended to base the quantitative analysis on the actual project schedule and CBS, using the information gathered in the qualitative risk session. One particular software tool that is explicitly designed for this purpose is Pertmaster. Pertmaster can easily load a project's schedule (either made in Microsoft Project or Primavera) and a qualitative risk register (Excel). From the analysis set out in chapter 6, it can be concluded that for large and complex projects one should draw

the model's structure from a typical level 2 project schedule, made up out of in between 150 or 300 activities that effectively captures the logic and sensitivities in the project's plan. Next, one can simply add uncertainty and risks to the model and compare different alternatives to assess the overall project risk profile.

Pertmaster is recommended as the best risk analysis tool for HMC because it is specifically designed for analyzing risk on complex offshore projects. The software is fully compatible with HMC's systems and can easily be integrated within their current management and planning process. Furthermore, HMC has recently bought a license for the use of Pertmaster and has already been on a management course with some of the organization's lead planners to assess and evaluate its usability. Using Pertmaster makes quantitative analysis very accessible, transparent and is relatively easy to use. Currently, there has been a pilot on using Pertmaster for analyzing the risk in the first large EPIC project that HMC performs. However as can be concluded from this pilot that quantitative analysis requires a lot of support, resources and an explicit infrastructure to gather the required information for a valid analysis. Hence, it cannot be overemphasized that an effective qualitative PRM process is a prerequisite for performing quantitative analysis. Making sure that there is a supportive infrastructure to develop a model, gather the necessary inputs, validate the analysis and interpret the output correctly. Otherwise such an investment can easily become in vain.

Make use of three-point estimates

Apart from developing a project-specific risk model with the use of schedule-based risk analysis software it is essential to put sufficient time and effort in gathering the required input data. As argued in section 6.4.2., HMC currently uses a meeting with the Project Manager and Cost estimator to quantify risks on their impact on the project as a whole, expressed in additional "offshore SSCV days". However there are a number of elements that cause bias in risk estimation, which should be addressed proactively. Some recommendations to increase the effectiveness and validity of quantitative risk analysis:

- **Separate Risk, Variability and Impact Uncertainty:** When analyzing and estimating risks from the qualitative risk register, a distinction should be made between risks that add uncertainty to the duration of a planned activity (activity variability or uncertainty) and risks that might occur and cause a change in the project plan (either an additional or change in the project plan). Hence, some risks can be added up to form an overall spread or uncertainty distribution, while others are specifically simulated within the project's model using probabilistic branching.
- **Make use of three point estimates:** Many risks in HMC's current model are single point estimates, using discrete risk distributions. However it has been argued in chapter 6.4.2 that our tendency towards precision causes these estimates to be biased. A more "accurate" risk estimate can be made by providing a range, e.g. the perceived minimum, most likely and maximum value. Quantitative analysis should be focused on providing range inputs to effectively analyze uncertainty and risk.
- **Rationalize on risks and their contingencies:** When analyzing risks and uncertainties in a predefined model, one should explicitly discuss risk estimates with the project's planners and budget holders to distract contingencies that are already in the planning. In many cases, risks have already been integrated in the initial estimates; hence the entire analysis is negatively biased. Furthermore, one should decide if a risk affects the entire project, a specific activity and how many times it might occur during the entire project lifecycle.
- **Incorporate correlation groups:** Especially in complex projects, there are a lot of risks that are correlated and might influence each other. Hence, it is important to collaborate and evaluate the risks in the model and make sure that the model reflects reality. Two activities might be influenced by the same risk, or one risk might directly influence another. In reality, risks are interdependent and the model should focus on including these relations and correlations as much as possible. For instance if the analysis gives that it is likely that the project becomes delayed, then there is higher change that the SSCV should move out because of bad weather.

Use quantitative analysis in an interactive manner to support decision-making

One of the frequent comments on applying quantitative techniques for the analysis of risk is that, because it is very labor intensive (many changes required for each update), project managers don't get deeply involved in the actual model construction (Murray-Webster and Simon, 2007). Many therefore perceive the use of Monte Carlo models as something of a black art, as it is not possible to see how risks relate and affect the project's activities and so it remains unclear how the input correlates with the eventual output (Loosemore, 2006). To achieve sufficient confidence in the applied tools and techniques to support decision-making, it is recommended to use a tool like Pertmaster as an integral part of all project management activities, rather than to treat risk analysis as a separate technique that provides an indication of the perceived risk.

The power of quantitative analysis is that it can help managers to visualize and manage risk more meaningfully in their budgets and schedules. Because it shows where risks are likely to occur and how the project's current cost and schedule data are used to feed the risk analysis. A graphical representation of the risk model, its causes, correlations and consequences and the evaluation of different alternatives can assist in making conscious decisions in the face of risk. It is recommended to use the model not only to estimate a valid contingency budget, but also to show the effectiveness of planned responses, compare alternatives, optimize resource allocation and estimate the perceived chance of success. Risk analysis ought to be performed before and after risk response planning. In this way the planned responses reflect the criticality and relative importance of risks within the project's network. At the same time one can show the perceived effect of these responses on the project's outcome. In addition to the scatter plots that are developed by the current HMC model, it is recommended to use both duration and cost S-curves to indicate the perceived chance of making the deterministic project plan. A few examples of quantitative analysis output using Pertmaster are given that might be used to support decision-making in complex EPRD projects (see figure 497).

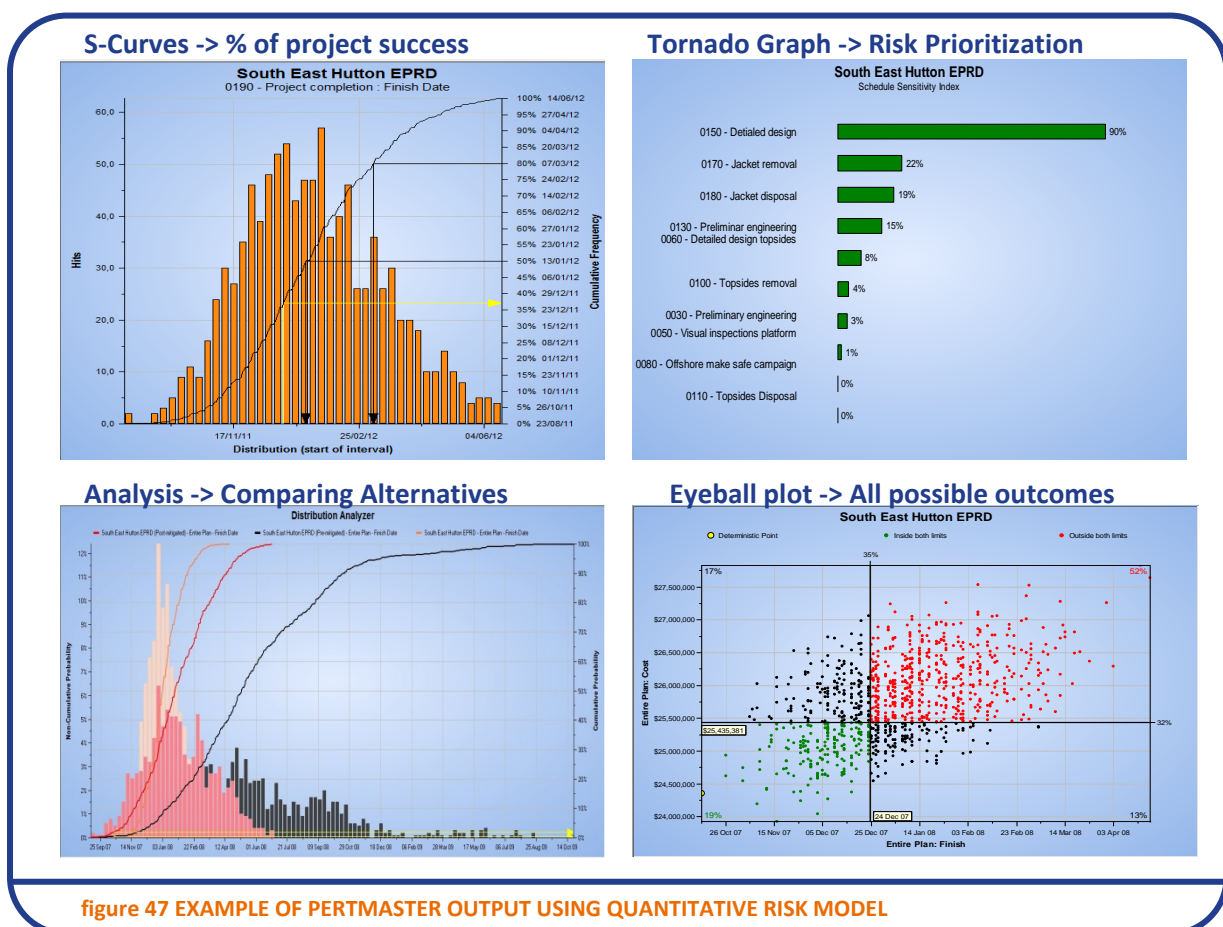


figure 47 EXAMPLE OF PERTMASTER OUTPUT USING QUANTITATIVE RISK MODEL

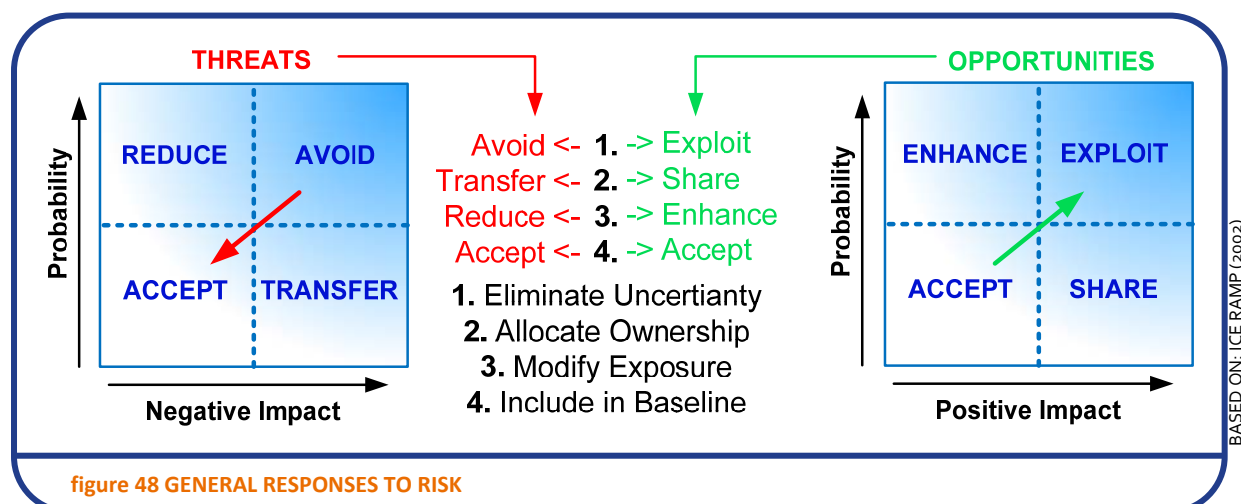
SOURCE : GENERAL PERTMASTER OUTPUT (2009)

7.1.7 QW7: Explicit planning, allocation and reporting on risk responses

From section 4.4.4 of the thesis report it can be concluded that the structural complexity, uniqueness and dynamics of EPRD projects cause *managerial complexity* of the project as a whole. Thereby the manager's ability is reduced to *predict, control and measure* the outcome of the project. It has been argued that it is far more difficult for a single project manager to be the one person at the top of the hierarchy who knows all and holds the power to manage each and every risk. Rather the project manager takes on the role of a facilitator, organizing mutual control and a risk responsibility among all project stakeholders. Thereby it is important to create a *collective* responsibility for managing the project's risks, making sure that everyone understands his tasks and proactively manages the perceived risks to the project as a whole. One of the most important aspects of an explicit risk management process is to allocate and divide the responsibility for actually "managing" risks among those people within the organization that are best placed to do so (Hillson and Simon, 2007). This will ensure that there is an explicit step within the risk process that focuses on developing, assessing, implementing and reporting on responses and actions to treat risks.

As can be seen from the analysis in section 6.5 of the report, there is currently only one person responsible for the management of risk in EPRD project, e.g. the respective Tender or Project Manager. During the risk workshop, risks are allocated to specific persons within the organization which are recorded in the project's risk register. However in the end, the register is controlled and managed by the Project Manager and it is his task to instigate, develop, approve, control and monitor responses to the identified risks (HMC PRM procedure). In practice this implies that risks are still managed implicitly (not explicitly controlled within the risk process) and that it still depends on the project manager if all the initial efforts and information is actively used to proactively manage project risks. With the amount of risks in current ERPD projects, it is almost impossible for one person to address all these risks at once, providing explicit risk response plans, actions and contingencies. Thus, it is recommended to include a specific "response planning" step in the risk process where each risk owner develops risk responses, response actions which are summarized and reported within the overall project risk register.

To do so, it is recommended to assign all risks to specific risk owners within the organization during the initial Risk Workshop. Next, these people should select a certain response strategy to treat each of these risks. Depending on the severity of the perceived risk (to which quantitative analysis might provide valuable input), a risk owner selects a general response strategy to each risk based on his specific knowledge, experience and responsibilities within the project. Currently at HMC risks are in most cases "mitigated" (see appendix M). However in fact there are four general responses to each risk, e.g. to *avoid/exploit, transfer/share, reduce/enhance* or *accept* a risk (see figure 48).



For large and complex EPRD projects, it is recommended that the risk coordinator interviews each risk owner for approximately two hours to step through the specific risks that fall under his responsibility and discuss risk responses. Next, it is essential that specific actions are developed to implement this strategy, so that it is not only clear how a risk ought to be managed, but also by whom, by what means, to which date and at what expenses. Next, all these elements are documented in the risk register that is available to the project manager, the project stakeholders and the risk owners, controlled and monitored by the risk coordinator (see figure 49). If there are no specific actions developed to proactively change the cause or effect of each risk, then in essence all the initial efforts have been in vain.

It is recommended that each risk-owner frequently holds a meeting with his department or “*project sub-team*” to discuss the risks, agree on the actions that need to be taken and report on their progress. Moreover, it is important to assess the perceived effectiveness of these actions in reducing the initial risk level, to give an overview of the results and effectiveness of the PRM process and to indicate the need for specific contingencies. Hence it is important to recognize that one always addresses both the source and effects of each risk, so that when the risk occurs and the taken actions proved to be ineffective, there is always some kind of contingency plan to solve the problem in an effective manner. The specific allocation of risks throughout the project’s organization ensures that actions are developed proactively. This will significantly improve the effectiveness of HMC’s current approach. It is recommended to change the current risk register to include more detailed information on risk responses (see table 17):

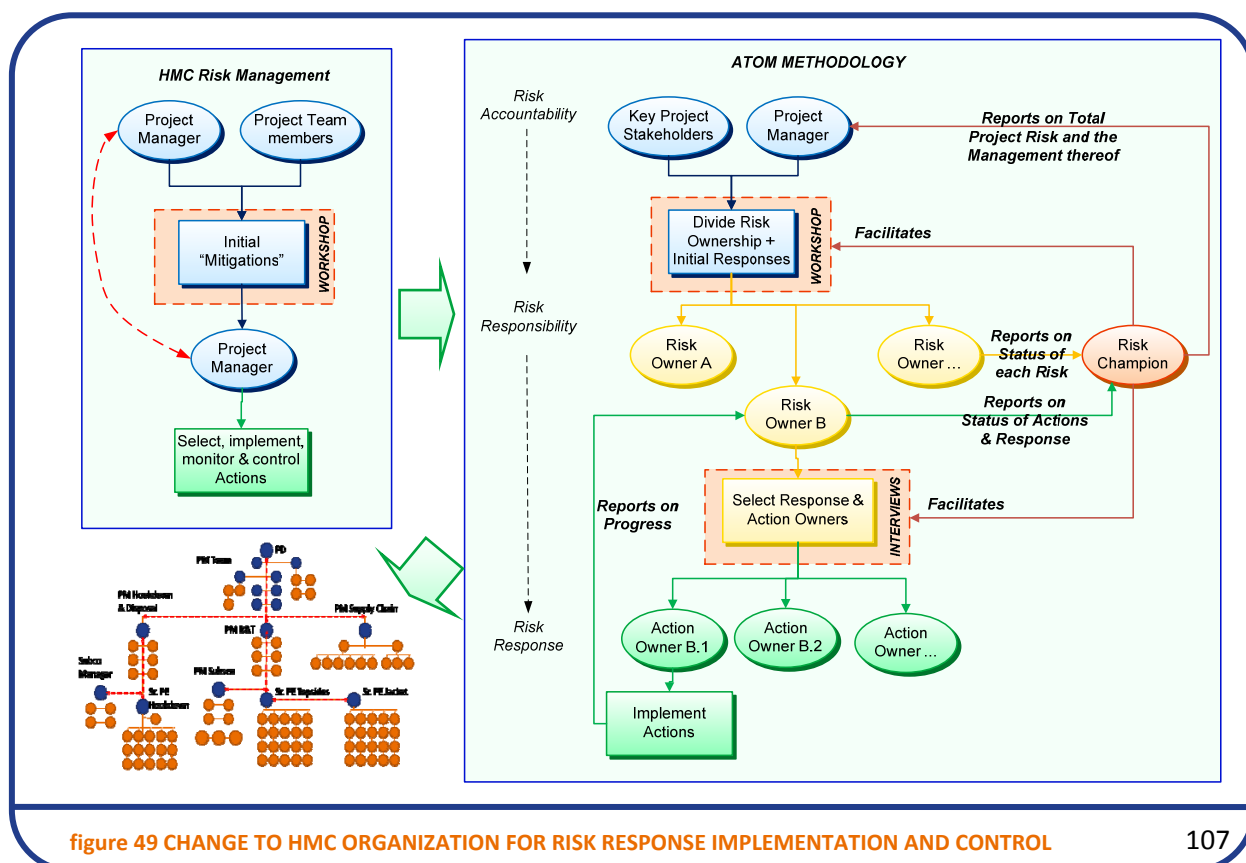
table 17 HMC Risk Register

Mitigation / Action	Person/ Department tasked	Due Date
Action 1	PM, PE	-
Action 2	Planning	Monthly
Action 3	Engineering	-
Action 4	PM	Weekly
Action 5	PM	-



Explicit Response Reporting in Risk Register

Risk Owner (Named Individual)	Risk Response : Avoid / Transfer / Reduce / Accept				
	Action(s) to Implement Strategy	Action Owner	Action by date	Costs	Comment / Status
P. de Groot	Action 1.1	P. Boer	01/06/09	-	
	Action 1.2	P. Boer	15/08/09	\$5.000	
J. Jansen	Risk Response : Avoid / Transfer / Reduce / Accept				
	Action 2.1	S. Loo	12/05/09	\$2.000	
	Action 2.2	S. Loo	04/04/09	\$200K	



7.1.8 QW8: Internal project risk champion for communication, control and monitoring

Currently, there is a risk coordinator for every HMC project that facilitates the process, develops and maintains the risk register and runs the quantitative risk analysis. However the control, monitoring and communication of risk documents still fall under the responsibility of the project's manager. As discussed in chapter 6.5.2, there are several reasons why risk management is ineffective if there is no explicit check or control. Empirical research has indicated that there are several conscious and subconscious reasons why people fail to implement preventive actions in the face of uncertainty (Kutch and Hall, 2009). Hence, it is recommended to assign a **Risk Champion** within complex EPRD projects to ensure that the actions and responses are implemented with enough rigor and vigilance.

A risk champion should have detailed knowledge on all the project elements to effectively analyze, assess and control PRM. In essence, a risk champion assists the project manager to remain an outward focus on the issues that matter the most, thereby providing the necessary information to support effective and efficient decision-making. One of the main tasks of the risk champion is to manage the risk process on a continuous basis. Preparing risk documents, a Risk Management Plan, maintaining the Risk Register and facilitating Risk meetings and Risk workshops. Furthermore it is up to the risk champion to address the barriers that hamper effective risk implementation, frequently checking progress on the agreed risk control measures and maintaining an overview of the development of risk during the project's lifecycle. Especially in complex EPRD projects, the project manager has an inward perspective, focusing on the issues that require immediate attention e.g. the daily project activities, thereby keeping the project team optimistic, motivated and enthusiastic in quickly solving project issues and problems. However, a good risk manager has an outward focus, constantly looking forward to take proactive actions on the risks that might affect the project in the future. PRM is therefore not about managing the problems at hand (likely to happen in the near future), but is about constantly harnessing all the knowledge within the organization to prevent these problems from happening in the first place (which uncertainty matters the most to the project's objectives). For any manager, it is very difficult to adopt both perspectives simultaneously, especially in a project with multiple stakeholders and separately coordinated teams. Hence, a risk champion is desired in these complex projects to support and manage the PRM process. His task is to provide the project manager with the most important risk information to ensure a balanced comparison of alternatives and necessary changes to the current project plan. At the same time he should question and check the project manager's decisions in the face of uncertainty. However it should be noted that the responsibility to manage the risks always *remains the responsibility of the project team* and that the risk champion is only responsible for managing the PRM process.

Empirical research by Raz et al. (2002) has shown that especially in projects with high uncertainty levels, a risk champion holds a significant contribution to keep the project within planned budget and to its initial schedule. However the same research concluded that in practice this rarely happens, as 64 out of the 82 respondents indicate that there has never been a single risk coordinator or champion within their projects. And only 18 participants answered that appointing a risk manager was applied to some extent, indicating the lack of an explicit risk champion on many of today's projects. Furthermore, one of the main conclusions of two similar thesis by Van Schaik (2005) and Spruit (2009), who investigated the alignment of the risk management process within a large construction contractor, was to include a "*risk expert*" or "*project risk consultant*" within each project. This person should actively support and execute the risk management process and thereby improve its effectiveness in practice. One might argue that especially in the offshore business, there is always an explicit "*Risk Manager*" to make sure that everybody adheres to all the safety procedures during the *execution* risky offshore campaign. Hence, it might not be so strange to have such a similar "*Risk Champion*" within the organization of complex and innovative projects to ensure that everybody adheres to the proactive management of project risks during the *preparation* of a risky offshore campaign.

7.1.9 QW9: Extend requirements of regularly risk updates – Include review in PSR meetings

As described in section 4.4 and 4.5, EPRD projects are inherently dynamic due to their large scope, duration, complexity and innovations. Thus it has been argued that EPRD projects require a continuous update and review of the project's risks along the entire project lifecycle. These updates should form an integrate part of the normal project management system and reporting cycle. However, as can be concluded from the analysis in section 6.6.1, that there currently are a number of "risk reviews" performed both inside and outside of HMC's PRM process. First, risks are reviewed by the project manager in regular project meetings. However it depends on the project manager's own interest and attitude how much time and effort is devoted to the review of the risk register. Hence, updates are not always explicitly documented and in many cases the reasons for risk changes are unknown. Next, there is an explicit update of the risk register and the risk model in a meeting with the risk coordinator, the project manager and the project controller. However this implies that many of the changes in the risk register still depend to a high degree on the perspective of the project manager instead of reassessing the risks in compliance with all the appointed risk owners. Finally, there is a monthly review of the project's main risks (top 10) in the Project Status Report (PSR) meeting with all project stakeholders. But it is up to the project manager which risks are discussed and how these are presented as there is no explicit check or review within the PSR meeting of the risk register and the specific actions that have been developed and implemented (see appendix M).

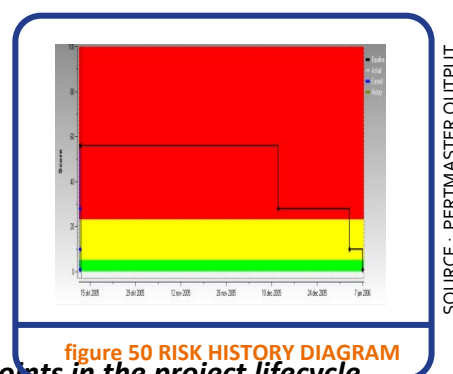
It is recommended to include a regular review of the project's risk register into the project management system. The aim is to make sure that there is no occasional discussion of the subject of risk within a project meeting, but that such a meeting is specifically facilitated by the risk champion and forms an integral part of the PRM process. Starting with the most important "red risks", there should be an open discussion and evaluation of the change in risk status (see figure 32), risk level, date of change, reason for change, action status, secondary risks and additional risks. This will make it possible to keep an extensive "risk change log" that can show the progress and results of the PRM process, indicating why and when the project's risk level changed (see figure 50). This will make clear if things simply turned out in favor of the project team or that the actual implementation of risk responses has been effective in reducing the project's risk level.

During the PSR meetings, it is recommended to not only report on the top 10 risks, but to check all the important "red risks" and "amber risks" in the project's risk register. Clearly discussing that actions have been developed, when they have been implemented and how the project's strategy has changed to make the plan either more robust or flexible. The results of the quantitative model might be used to support decision-making and indicate the change in the overall risk profile of the project, thereby justifying the expenses that have been made proactively to reduce the chance of costly problems in the future. During a PSR meeting, the risk champion can give a small update on the effectiveness of the applied process, showing the difference between the pre-response and post-response project risk levels. Furthermore one might use a small risk report summary to highlight the most important risks that have occurred, as well as the most important risk response actions that have been implemented.

Report on:

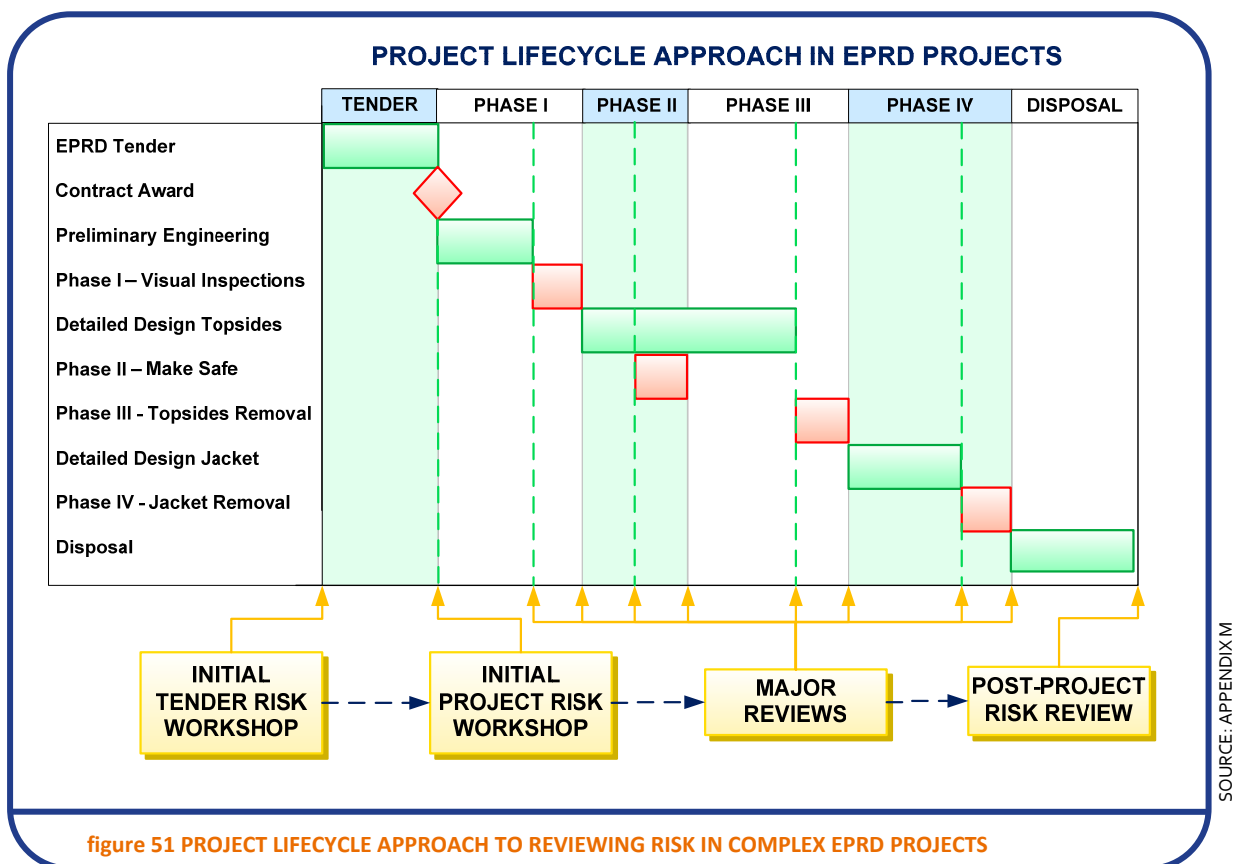
- **Risk Status** (Draft, Active, Closed, Deleted, Expired, Occurred)
- **Risk Level** (Pre and post-mitigation probability and impact)
- **Date Risk Raised**
- **Date Risk Excluded** (Closed, Deleted, Expired, Occurred)
- **Action Status** (Draft, Active, Closed, Expired, Implemented)
- **Action by Date**
- **Date Action Implemented**
- **Cost of Response Action** (Contingency or direct cost)

7.1.10 QW10: Hold Major Risk Review Workshops at key points in the project lifecycle



Apart from regularly updating the risk register in PSR meetings and during the normal project reporting cycle, section 6.6.1 of the report expressed the need for a number of major reviews. The current EPRD methodology that HMC applies divides the project into several distinct phases (see appendix G), e.g. the visual inspections of the platform, the make safe campaign, the topsides removal and the jacket removal. Accordingly, it is recommended to plan a Major Risk Review workshop at the beginning of each of these phases (see figure 51).

As discussed in chapter 4, a large part of the project's scope of work is unknown at the start of a large EPRD project. Mostly, because the platforms are over 30 years of age and are in a very bad condition. So before the project team can start planning the entire project, there is a preliminary phase in which each platform is carefully studied and visited to examine the platform's topsides and jacket structure. The required preparation and hook down activities are of a particular concern in this phase, as there are a lot of surveys required to estimate and plan all the necessary activities. Hence, during the first phase there will be a lot of new information on the platform's removal case. The same counts for all the other phases that together make up the entire removal lifecycle. Accordingly, there is no single project plan for the removal of an offshore platform, but there are various schedules and project plans as the platform is removed during three separate offshore campaigns. At the start of each of these phases, there is a significant change of the overall "risk level". For instance, after the make safe period, there is a lot of new information on the platform that might cause additional risk. And at the same time there are many risks that have either occurred or are expired because they only affected activities within the make safe period. Hence, at the beginning of each phase there is a need to critically review the entire risk register and hold a "Major Risk Review" workshop with all project stakeholders to not only evaluate the previous offshore campaign, but also shift the project team's focus to the objectives of the next phase.



Next to a risk review meeting at the start of each project phase, it is also recommended to explicitly review the risk register at the end of every phase. At HMC, the overall “*project risk profile*” is handed-over in between project phases among several separate departments. During the project’s tender, the tender manager is responsible for the project’s strategic risks and will make decisions on how these risks are dealt with in the project’s bid and contract. Next, the risk profile is handed over to the project manager who is responsible for planning and coordinating the project and all the necessary preparations for the offshore campaign. Important decisions have to be made on the overall removal approach and how to best use the project’s resources to reduce risks. And finally, the risks within the project are handed over to the project’s operational manager that makes the decisions during the project’s execution offshore. This focuses on a safe and timely performance of the crew that operates HMC’s SSCVs. So in fact, risks are handed over in between different teams within HMC’s organization, and one might use the risk register as a tool to effectively communicate about these risks. The tender manager might clarify and explain his decisions and choices that make up the project’s Business Case to the project manager. And in the same line of reasoning the project manager might inform the project’s operational manager on the risks that are associated with the eventual plan for the offshore campaign. It is recommended to plan various explicit risk review sessions throughout the entire project lifecycle that form an integrate part of the PRM process, ensuring that these meetings take place at critical moments along the entire project lifecycle.

Currently, no specific major risk review workshops are included in HMC’s risk process. In line with the ATOM methodology, it is recommended to plan a full day for a Major Risk Review meeting at the start of each project phase. Such a meeting should focus on reviewing the risk register, identifying new risks and developing actions to address these risks. Furthermore, such a workshop offers the opportunity to discuss the effectiveness of the risk process itself and decide if it is desired to make any changes to the chosen approach.

For the explicit handover of the risk’s register in between the various project phases, it is recommended to plan a meeting of approximately half a day. This allows enough time to step through the entire risk register and indicate which choices have been made as a response to the identified project risks. Furthermore, it is essential to discuss the risk areas that still remain within the project, for which emergency or contingency plans have been developed.

7.1.11 QW11: Capture risk knowledge and risk lessons learned at the end of each project

Finally, it is recommended to explicitly review the risk register, risk documents and the development of the project’s risk profile at the end of current EPRD projects. The risk register contains detailed information on the risks that have actually occurred and therefore might affect future projects, as well as effectiveness of risk response actions that provide important lessons to HMC as an organization. Especially because HMC is still at the beginning of the learning curve, it is very important to effectively gather information from previous EPRD projects to improve the management of risks in similar project in the near future.

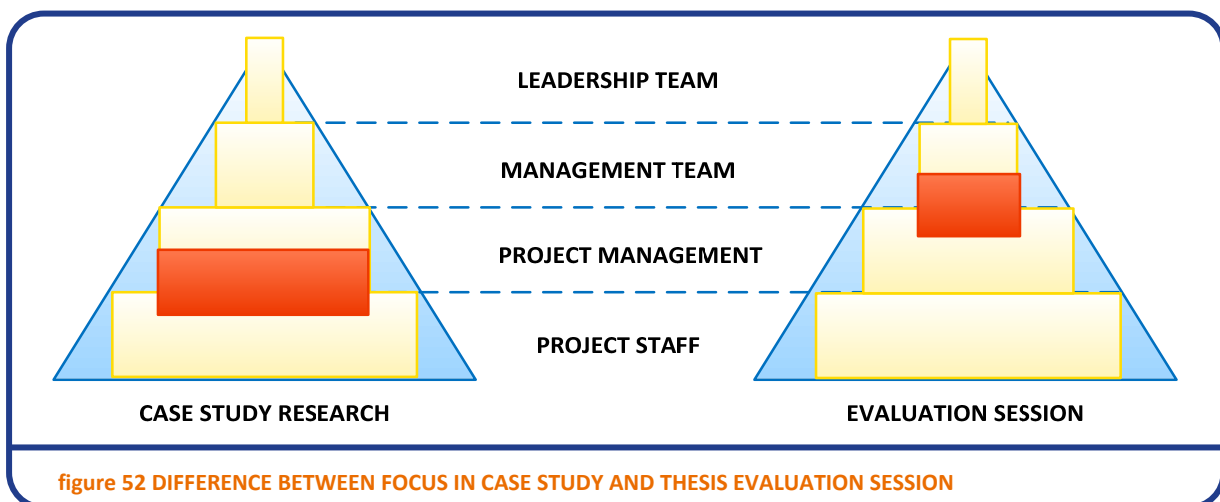
It is recommended to integrate the post-project risk review within the normal lessons learned sessions that HMC undertakes for all of their projects. Stepping through the risk register, add risks that have occurred to a company risk database or use these to make a specific risk checklist that can be used for risk identification purposes. Next, it is recommended to review the process itself to determine its effectiveness in coping with the perceived risk profile of the project. A specific section of the final “as-removed” report may be devoted to the Risk Management Plan and the application of PRM process in practice. Next, one might want to compare the actual costs and durations of the projects to the initial estimates to identify significant differences that can be used to improve future cost and schedule estimates.

7.2 Interactive evaluation session with HMC management

In the previous section of this chapter, a total of 10 quick wins have been identified and described that can quickly improve the effectiveness of the HMC PRM process to better cope with the risks in complex EPRD projects. This thesis generates solution-oriented knowledge to develop a tailored approach for HMC. The recommendations for improving the HMC PRM process are the result of *multi-methodological* research, combining the findings from an extensive case study with literature on the current “best practice” PRM process.

However, as discussed in chapter 3, there are various people involved in the management of project risk that might have opposing perspectives on the importance of explicit PRM and the desire for improving the current approach. Some might embrace the recommendations set out in this thesis chapter, while there might be others who do not see the reason to improve PRM in the first place.

Accordingly, the most important findings and recommendations of the thesis have been evaluated in an interactive session with HMC management, to gather a sufficient amount of feedback in a relative short period of time. As the internal research project mainly focused on a managerial level within EPRD projects, this workshop has been organized for the departmental managers that take part in the top Management Team of HMC (see figure 52). They are the ones that can make a significant change to HMC procedures and the way risks are managed in future EPRD projects. Therefore, the evaluation session focused on discussing the importance of PRM in EPRD projects as well as the recommendations for improving the current PRM approach. This has created an opportunity to see if management recognizes the thesis findings and if the recommendations set out in previous chapters are desired and perceived to be effective in improving PRM within HMC. Furthermore it offered an unique opportunity to evaluate the results of the thesis and identify additional elements and issues that are currently lacking.



Apart from evaluating and discussing the thesis’ findings, the interactive session has been organized to address the issues considered with a recent change to the HCM PRM procedure. In the beginning of September 2009, there has been a major change to the organization of PRM within HMC. The leadership team of HMC has decided to abandon the central facilitation of risk management within the Legal Department. This implies that the entire PRM process (and all the activities within this process) again falls under the full responsibility of the respective Tender and Project Manager. Consequently, the role of the risk coordinator within HMC ceases to exist as well as the application of quantitative risk analysis which had been facilitated by the Legal Department. It is therefore important to discuss the implications of this change for the management of risk in the complex and innovative projects that HMC currently performs; recognizing the fact that an approach to manage risk should be specialized and fitted to the project's risk profile for which a more de-central approach might be beneficial.

7.2.1 Session lay-out and focus

In order to provide a valuable discussion within a short amount of time, it was decided to focus on three essential elements that are of a particular interest to the management of risk in EPRD projects:

- Who should take responsibility for the management of risk?
- How can we assure an integrate approach to managing risk throughout the entire project lifecycle?
- How should we use risk information to support decision making, including risk in our budgets and schedules to increase the change of project success?

For each of these issues, a separate discussion has been facilitated within the workshop in order to identify if these issues are recognized as being important in current EPRD projects. The goal was to find out if everybody agreed that a change is desired in the light of the current approach and PRM procedure and that the thesis recommendations are perceived as a valuable to solve current issues. Finally the question was raised which steps will be taken to address these issues in practice.

The entire session had been scheduled to last for 2 hours, in which there has been a short introduction to clarify the cause and motive of the workshop, followed by the three separate discussions among HMC management. Finally, additional thesis findings and recommendations have been presented to conclude the meeting.

One of the important aspects of an effective workshop is that there are enough people to provide a valuable discussion and input to achieve the workshop's goals, while at the same time too many attendants might increase the difficulty of an open, effective and efficient meeting. Accordingly, it was decided to select a group of 10 people that together could provide a broad and balanced group of persons within HMC that are responsible for PRM in EPRD projects. Both people from the Tender and Project Management Department have been invited, as well as the main users of the process (Tender and Project Managers) and their superiors who are responsible for the overall procedures. Next, the departmental managers of the Financial, Planning and Engineering departments have been invited as each of these might have a different perspective on how risks should be managed and integrated to support decision-making. Eventually, nine out of the 10 invited have attended the workshop:

WORKSHOP ATTENDENTS

- Risk Coordinator (NWH and Ekofisk)
- Project Director Ekofisk EPRD
- Project Director NWH EPRD
- Manager Finance and Control
- Manager of Projects
- Manager Planning
- Sr. Tender Manager
- Manager Tender & Contracts
- Engineering Manager Decommissioning and Removal

WORKSHOP OUTLINE 30/09/09-> (90-120 min.)

1. Presentation of Workshop Motive (20 min.)
2. Open discussion on RM in EPRDs (45 min.)
 - *Risk Management Responsibility*
 - *Project Lifecycle approach to risk*
 - *Risk info to support decisions*
3. Recommendation from thesis (25 min.)
 - *What is Best Practice Risk Management*
 - *Quick Wins for improvement*
 - *Critical Success Factors*
 - *Use of Pertmaster for Quantitative analysis*

7.2.2 Results of interactive evaluation session with HMC Management Team

During the evaluation session, there have been a number of valuable discussions on the subject of PRM. It can be concluded that most attendants agreed on the differences between conventional installations and complex EPRD projects, however there were different perspectives among the attendees on the sources of risk in current EPRD projects. The difference in focus between HMC and the client organization was recognized as an important and clear element that caused additional risk to HMC as a contractor. Next, a few elements where highlighted during the sessions of which the three most important will be discussed.

1. Awareness of project risk profile in early project phases - Using a project sizing tool

An important element that came forward during the session was the need to explicitly discuss and evaluate the risk profile of every project at the start of the PM process. It should be clear beforehand why HMC chooses to tender on a certain project and what are the particular objectives and risks that make up the project's Business Case. The difference in risk profile should be recognized between more conventional projects and those projects that are highly unique and innovative (and are therefore inherently risky). Especially with the first EPRD project HMC acquired, there has been a huge underestimation of the complexity and perceived uncertainty that affected the project's outcome. Hence, it was recognized during the feedback session that the inclusion of a risk initiation meeting would significantly improve the effectiveness of managing risks throughout the entire project lifecycle. This means creating awareness in the front-end development of the project to decide on desired approach to best manage the project's uncertainty. However as the thesis recommendations indicate the need, requirements and focus of an initiation meeting as an integral part of the PRM process, the workshop attendees asked the question of an effective and efficient way to assess the overall project risk level.

Consequently, a specific project sizing tool has been developed to support the evaluation and discussion of risk in the initial phases of the project's development, providing a concrete solution to the issue that was brought forward during the evaluation workshop (see table 18). The sizing tool is based on a method prescribed by Hillson and Simon (2007) to quickly assess the project's risk profile and label the project as being "small", "medium" or "large".

table 18 Project sizing Tool for HMC, based on tool from Hillson and Simon (2007)

Criterion	Criterion Value = 2	Criterion Value = 4	Criterion Value = 8	Criterion Value = 16	Criterion Score
Strategic importance to HMC business	Minor contribution to business objectives	Significant contribution to business objectives	Major contribution to business objectives	Critical to business success	
Commercial / contractual complexity	No unusual commercial arrangements or conditions	Minor deviation from existing commercial practices	Novel commercial practices, new to at least one party	Groundbreaking commercial practices	
External constraints and dependencies	None	Some external influence on elements of the project	Key project constraints depend on external factors	Overall project success depends on external factors	
Requirement stability (influence of client)	Clear, fully defined, agreed objectives	Some requirement uncertainty, minor changes during the project	Key project objectives depend on external factors	Requirements not finalized and subject to negotiation	
Technical complexity	Routine repeat business, no new technology	Enhancement of existing product / service	Novel product / project with some innovation	Groundbreaking project with high level of innovation	
Market sector regulatory characteristics	No regulatory	Standard regulatory framework	Challenging regulatory requirements	Highly regulated or novel sector	
Project value	Small project value (<\$10M)	Significant project value (\$10M-\$20M)	Major project value (\$20M-\$75M)	Large project value (>\$75M)	
Project duration	Duration <3 months	Duration 3-12 months	Duration 1-3 years	Duration >3 years	
Project resources and organizational complexity	Small in-house project team	Medium in-house project team	Large internal and external project team	Large project team including many subcontractors	
Project Environment	Known offshore project location	New location in routine environment	Novel project environment	High risk project environment	

>75 = Large project (High Risk Profile), 35-74 = Medium project, <35 = Small project (Low Risk Profile)

2. Explicit facilitation, monitoring and control by risk champion

Next, the discussion focused on the actual management of risks in practice, given that currently the implementation of risk responses and actions is still performed in an implicit manner by the project's Tender and Project Manager. It was argued during the evaluation session by the project's manager that in many cases nothing happens because there is no external check or control. Accordingly, it has been discussed to include a risk champion in complex and innovative projects to control, monitor and manage the HMC PRM process. During and after the meetings there were many questions on the specific profile and tasks of such a risk champion to increase the effectiveness of the current PRM approach. It has therefore been decided to include a general profile description of a typical risk champion in complex projects, which would significantly increase the effectiveness of the current HMC PRM process.

Risk Champion Profile and Responsibilities

The Risk Champion is a person with the necessary skills, knowledge and leadership required to "champion" the PRM process. A Risk Champion is responsible for overseeing and managing the risk management process on a day-to-day basis which may be a full-time or part-time job. It should be somebody on the level of senior management, who has a significant amount of experience with the management of HMC projects. The Risk Champion reports directly to the Project Manager and takes part in the project's Management Team. A Risk Champion should have sufficient authority within HMC's organization to drive and promote PRM throughout the entire project lifecycle, making sure that the barriers that hamper the effective management of risks are overcome, and to provide guidance and support when needed.

The profile of a risk champion includes someone who has:

- A good understanding of risk concepts, principles and processes
- Good analytical skills to assist with the analysis of root causes to risk problems
- Leadership and motivational qualities
- Good communication skills
- Experience in managing offshore projects

The tasks of the risk champion include (Hillson and Simon, 2007):

- Preparing the Risk Management Plan
- Facilitating the risk workshops and risk reviews at which risks are identified and assessed
- Creating and maintaining the Risk Register
- Interviewing risk owners to determine risk responses
- Ensuring the quality of all risk data
- Providing the necessary inputs for the development of a quantitative risk model
- Analyzing risk data and producing risk reports
- Reviewing progress of risk responses and their associated actions with risk owners
- Advising the project manager on all matters relating to risk management
- Coaching and mentoring team members and other stakeholders on aspects of PRM

3. Integration of qualitative and quantitative risk management with the use of a Software model

During the Risk review meeting attendants recognized the importance and potential of using quantitative risk analysis techniques to support decision-making. However one of the questions that came forward was how one might use the information gathered in risk workshops for the development of a specific risk model. And vice versa, how should the results of the quantitative analysis be used in the overall PRM process to support decision-making? Using the recommendations described in this chapter, a process overview has been created in addition to the eleven quick wins that given an overview of the relationship between the various stages in qualitative and quantitative PRM.

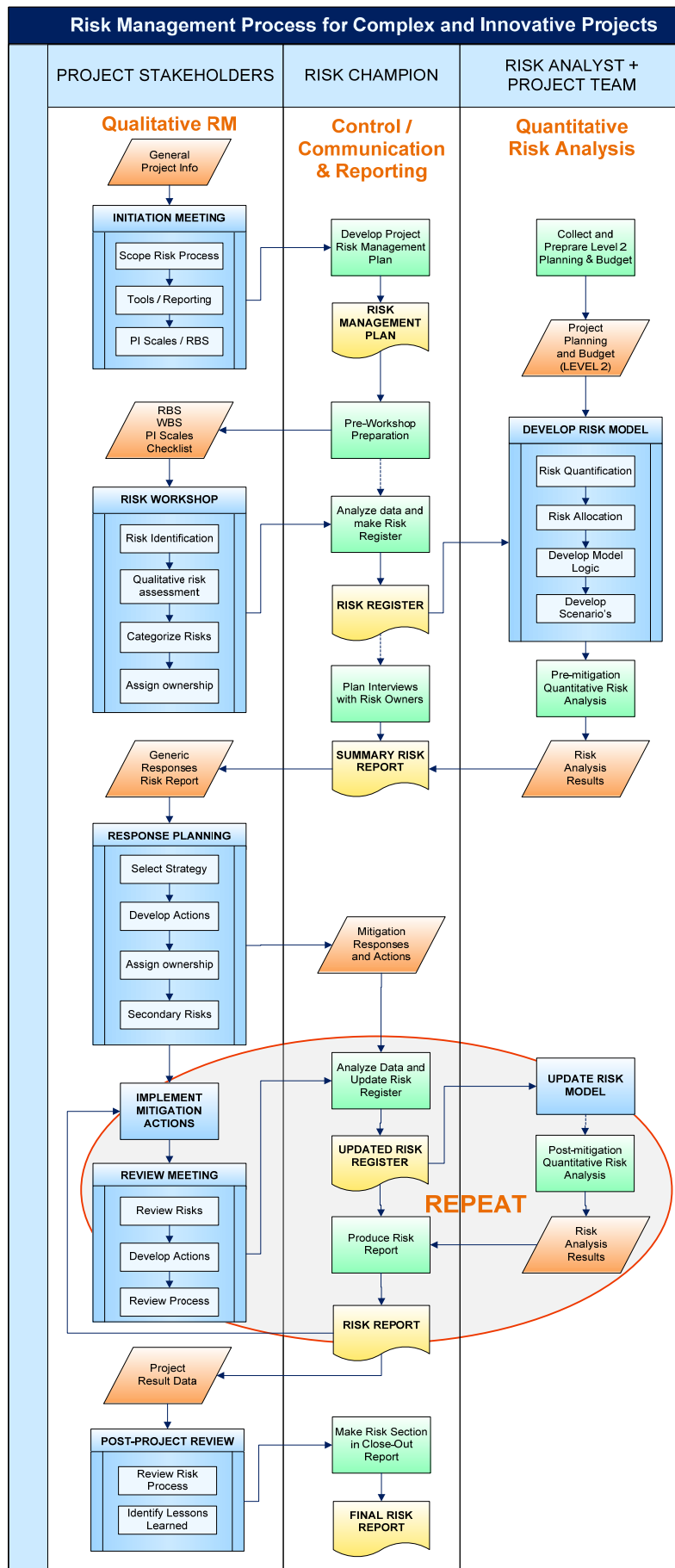


figure 53 INTEGRATED QUALITATIVE & QUANTITATIVE PRM PROCESS

From figure 53, it can be seen that a risk champion is essential to provide the necessary link between qualitative and quantitative risk analysis. A distinction is made between the project's stakeholders (client, HMC, project Team, Project Manager and subcontractors) and the Risk Analysts (Software expert, Project Planner and Risk owners within the Project Team).

Qualitative risk management is driven by the Risk Management Plan, which results from the initiation meeting at the beginning of the project. Next, the risk information gathered in the risk workshop is summarized in the project's risk register that contains specific information on the risks, their owners and their perceived priority.

The qualitative risk register is used in a separate workshop with the project's risk owners, planner and cost controller to develop a valid risk model in a software tool like Pertmaster, based on the project's level 2 offshore schedule. The results of the eventual analysis are summarized in an extensive risk report. Next, the Risk Champion plans and conducts a number of interviews with the project's risk owners to determine the specific response strategy and actions. The risk register is updated and the project's risk model is used to analyze the effect of planned actions. Final results are documented by the Risk Champion in an overall risk report which holds specific information on the current risk status, results of the quantitative analysis and the agreed and planned actions to address risks proactively.

These actions are implemented continuously by the designated Action Owner and reviewed during Minor and Major Risk Review sessions.

After the entire project is completed, a Post-Project Review session is held to capture the specific lessons learned, develop risk checklists and add a specific section in the close-out report on the effectiveness of the risk process.

Chapter 8

"It must be remembered that there is nothing more difficult to plan, more doubtful of success nor more dangerous to manage than the creation of a new system. For the initiator has the enmity of all who profit by the preservation of the old institution and merely lukewarm defenders in those who would gain by the new one"
Niccolo Machiavelli

- 8.1 Individual and collective risk attitude**
- 8.2 Is PRM worth the investment?**
- 8.3 When is a project successful?**
- 8.4 The human dimension of PRM**
- 8.5 Implications of soft aspects for implementing thesis recommendations**

8. Thesis Discussion



Within this thesis, there has been a focus on the process, tools and techniques used for effectively managing project risks. Hence, the recommendations and analysis described in the previous chapters consider the different steps that make up the PRM process and how one might organize and implement such a process across the entire lifecycle of a complex EPRD project. However, for risk management to be effective one needs far more than just a simple, scalable and effective process (Hillson and Simon, 2007; Loosemore et al., 2006). Recently more and more risk practitioners and researchers indicate the importance of “behavioural factors” that greatly affect the outcome of the risk management process in practice (Hillson and Murray-Webster, 2007; Kutch and Hall, 2009). One might use or implement the most sophisticated processes, tools and techniques to manage risk and still fail to achieve the promised results (Arrow, 2008). This chapter therefore provides a short discussion on the chosen approach and recommendations within this thesis.

The ultimate aim of a good risk management process is to “*change the way we think in the face of uncertainty*” (Cooke-Davies, 2005). It is therefore important to recognize the fact that risks are inevitable and that one should use all its knowledge of the future, to make better decisions today. Consequently, there is no easy way of mastering risk management, as it resembles more of a discipline than a process, tool or technique (Cooke-Davies, 2002). In fact the real challenge of HMC is to continuously practice and repeat PRM in such a way that it eventually becomes a cultural imperative. PRM should form an integrate part of the company’s business culture, as successful businesses and projects don't *react to change*, but adopt a common attitude towards the proactive anticipation and *management of change* (Galarath, 2006).

In this chapter, some of the most important “soft” factors that influence the effectiveness of PRM in practice will be discussed. The eleven quick wins described in chapter 7 that focus on changing the PRM process will only be successful if one addresses the human dimension that affects their implementation in practice (Hillson, 2007). In doing so, one should focus on creating a “*risk mature*” attitude and culture, and a people-centred approach to gain true commitment as well as the active participation of all members within the organization (Hillson and Simon, 2007). After all, the perception of risk and the management thereof is dependent on people.

8.1 Individual and collective risk attitude

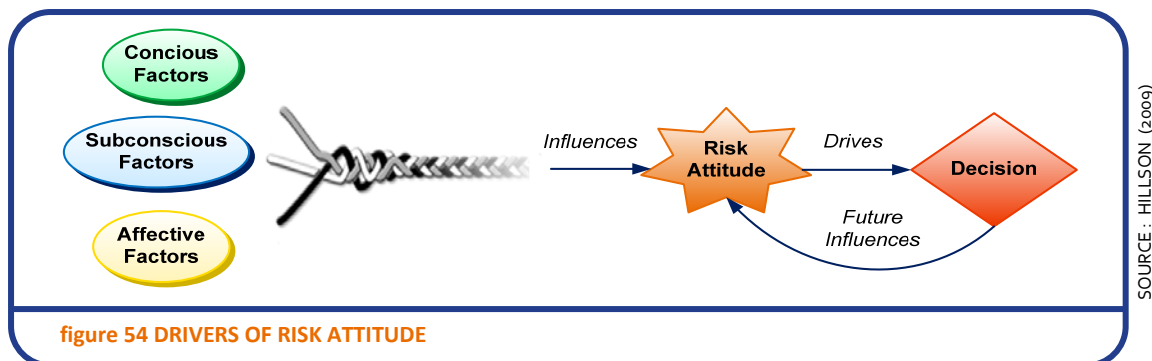
One of the primary reasons why risk management fails in practice is the attitude that individuals and groups hold towards the perceived threats and opportunities within a project (Hillson and Murray-Webster, 2008). Undoubtedly, the attitude to risk defers from person to person, team to team,

organization to organization etc. Accordingly, risk attitude significantly affects the PRM process and its application in practice. For the effective use of tools and techniques within a PRM process, it is considered of importance to understand something of risk psychology, and our conscious and subconscious biases that affect the way we think or feel about risk (see figure 54). Murray Webster and Simon (2007) argue that for PRM to be effective, one needs to move beyond a focus on the risk process towards a *people-centered* approach for managing project risk. Arrow (2008) gives that PRM “can never succeed if it is not embraced at a cultural level”

8.1.1 Defining risk attitude

Risk attitude is defined as the “*chosen response of an individual or group to uncertainty, driven by perception*” (Hillson and Murray Webster, 2008). The perceptions that drive our risk attitude are influenced by many factors but can be grouped under three main headings (Hillson, 2009):

- **Conscious factors:** These are the visible and measurable characteristics of a particular risky situation, based on our rational assessment. We also take account of situational factors such as whether we have done anything similar before (familiarity), the degree to which we have control of the situation (manageability) or how soon the situation is expected to affect us (proximity)
- **Subconscious factors:** These include all kinds of heuristics (our mental short-cuts based on experience) and other sources of cognitive bias. Some of our heuristics help us to quickly reach a good position while others may be misleading (planning fallacy). Common heuristics include memory of events (availability), or the conviction that we already know the right answer (confirmation trap).
- **Affective factors:** These are our gut-level feelings and emotions which rise up automatically or instinctively in a situation, thereby influencing our reactions. Fear, excitement or attraction can cause us to adopt a certain attitude that is distinct from a rational perspective



Together these factors influence our “*risk perception*”, however it remains hard to track back the specific source of this perception as all these psychological elements become intertwined. Two important aspects of the risk process are affected by our differing perception and attitude towards risk. On one hand we all have a different perspective on how “*risky*” a particular situation is. And on the other hand, we think differently about the best way to respond to risk. A summary of the most common behavioral factors that influence our risk perception and attitude is shown in table 19.

In the light of the underestimation of the studied case (NWH project, see appendix L), it is considered of value to discuss a set of common causes that might enhance a “*conspiracy of optimism*” in innovative and complex projects. According to the RUSI acquisition focus group (2007), our collaborative behavior (often by accident than being common purpose) and optimistic attitude towards project outcomes creates a natural “*optimism bias*”. Executives often exaggerate the benefits and discount the cost of projects, setting themselves up for failure (Hammond, 2003). Lovano and Kahneman (2003) confirm our natural *delusion of success*, giving that the risks in complex projects are not deliberately taken by the project’s management because decisions are in many cases affected by psychological traps. These traps influence the way we think when faced with uncertain or risky situations, and proliferate bad decisions which might ruin a project, company or career.

table 19 Summary of potential influences on perception of risk and risk attitude (Hillson, 2009)

CONSCIOUS FACTORS	SUBCONSCIOUS FACTORS		AFFECTIVE FACTORS
	HEURISTICS	COGNITIVE BIAS	
Familiarity	Intuition	Prospect Theory	Fear (dread, worry, concern)
Manageability	Representativeness	Repetition Bias	Desire (excitement, wonder)
Proximity	Availability	Illusion of control	Love (lust, adoration, attraction)
Propinquity	Confirmation Trap	Illusion of knowledge	Hate (dislike, disgust)
Severity of impact	Lure of Choice	Intelligence Trap	Joy (Happy, carefree)
Group dynamics	Affect heuristic	Optimism Bias	Sadness (depressed, morbid)
Organizational culture	Anchoring	Fatalism Bias	
	Groupthink	Precautionary Principle	
		Hindsight Bias	

The optimism that affects decision-making in complex and risky project stems from a number of common causes:

Causes of **Optimism bias** in estimating complex and risky projects (RUSI focus group, 2007)

- **Aspirations:** Having a high ambition to keep up the company's standards and reputation as a result of past successes, resulting in optimistic estimates.
- **Entryism:** The strong desire to gain a project shifts attention away from its risks
- **Industry's "Must Win" or "Can Do" mentality:** Having the perception that every project is doable, focusing attention on acquiring the project and then after the buy-in trying to increase the profit margin as the project proceeds
- **Risk of Technical innovation:** Underestimation of the costs and time needed for testing and developing new technologies
- **Lack of transparency in decision-making:** Sheltering crucial decision-making from blame increases optimistic decisions on schedules and budgets to increase the chance of winning the project.
- **Planning Fallacy:** Tendency to underestimate time, cost, risks of future actions while at the same time overestimating the benefits of these actions.
- **Confirming Evidence:** Seeking information that supports your existing point of view

Psychological traps that affect decision making under uncertainty (Lovano and Kahneman, 2003)

- **Tendency to exaggerate our capabilities:** Our mind sees risk and uncertainty often through rose-tinted glasses. Hence, humans have a tendency to exaggerate their talents and capabilities, which is amplified by the fact that we are more eager to take the credits for a positive outcome and contribute faults or negative outcomes to external factors.
- **Anchoring:** The initial forecast or estimate function as a starting point that is subject to little changes as the project proposal proceeds. There are no sufficient adjustments made to count for the real likelihood of problems, delays and scope changes.
- **Competing neglect:** We underestimate the potential abilities and actions of our rival's as a result of our natural inward focus.
- **Discouraging Pessimism:** Bringers of bad news become outcasts or are ignored by others, which encourages a more optimistic than realistic perception within groups. Consequently, people will hold back in pointing out all the negative aspects of a project.

It seems that our tendency towards optimism is unavoidable when making project estimates under uncertainty. However it is not very likely that one could easily remove optimism bias from a company's practice (Lovano and Kahneman, 2003). On the contrary, it is never desired to take out optimism from a project's organization, as it provides the necessary enthusiasm and enables people to be more resilient when confronted with difficult situations and challenging goals. The balance between healthy optimism and realistic risk taking is crucial for all successful projects and businesses. However when making budgets or plans for a complex project it is important to understand the sources of *over-optimism*, to make sure that plans remain achievable.

Flyvberg (2003) has shown that for decades our forecast of the costs and duration of large and complex technological projects have remained inaccurate, which forms a major source of risk in these kinds of projects. His study of over a 170 large transportation and infrastructure projects shows a structural underestimation of the cost and demand forecasts over the past 30 years. A recent paper on this subject (Flyvberg, 2006) gives that there are psychological and political explanations for our inaccuracy, which complement each other under the influence of political and organizational pressure. Where the organizational pressure is absent or low, it is found that most people judge future events in a more positive light, which creates *optimism bias*. Optimism bias is considered as a form of self-deception, which is in fact unintentional but might significantly affect our estimates. However where the organizational or political pressures are high, inaccurate forecasts seem to become intentional, which is labeled by Flyvberg (2006) as: *strategic misrepresentation*. Strategic misrepresentation implies that managers deliberately and strategically underestimate the costs of a project, to increase the chance their project is approved instead of the project of the competition.

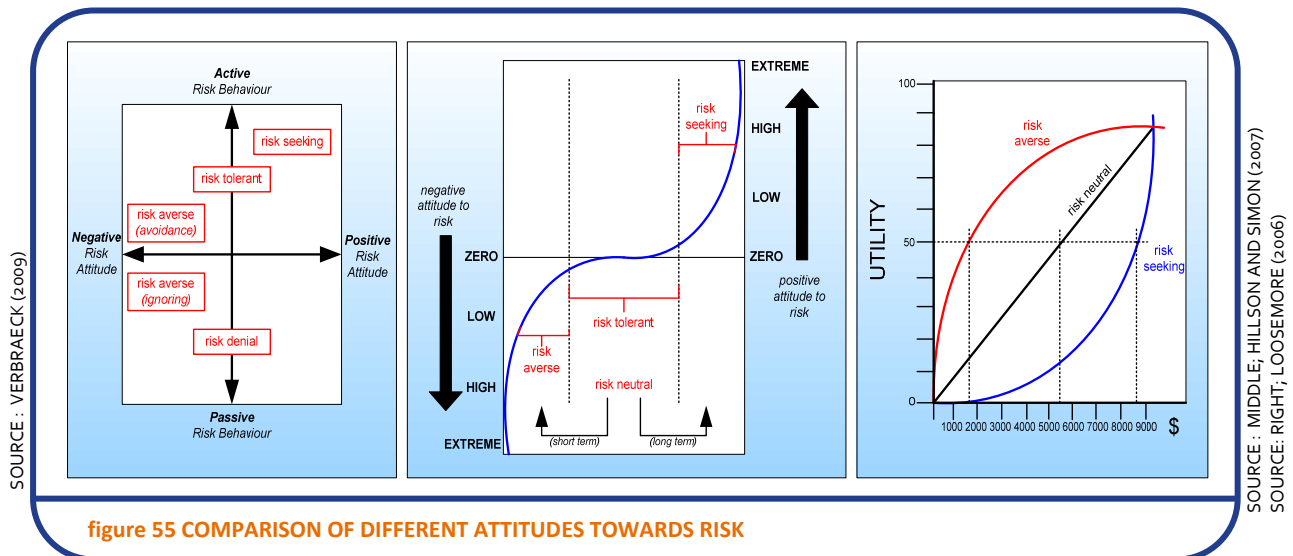
Whether the underestimation of the NWH forecast has been caused by optimism bias or by strategic misrepresentation remains unclear, however recent studies indicate that it is desired to change our conventional forecasting methods to ensure estimates of complex technological projects become more accurate. Experimental research by Lovanno and Kahneman (2003) has shown that "*reference class forecasting*" is considered to be a valid method to rule out our human judgment and optimism bias as much as possible. Reference class forecasting is a method that takes an "outside view" on our project's plans, by placing the project in a statistical distribution of outcomes of similar projects. This implies that one should abandon the traditional view on forecasting in complex projects which focuses on the project itself and its details (the inside view). Murray-Webster and Simon (2007) indicate that in most cases our estimates are no more than "best guesses", as it is very difficult to give a solid prediction of project's unique or unusual features. Reference class forecasting uses the results of many projects in a similar category, giving their cost overrun compared to the initial budget estimates. In essence, one can create a distribution of the cost overruns of a certain group of projects and thereby create a graphical representation of our common bias in forecasting. Next, one should assess the place of the novel project on this distribution, so it becomes possible to calculate an "uplift factor" that can be used to increase the accuracy of the initial project forecast. Especially for the large, complex and innovative projects HMC takes on it is recommended to use reference class forecasting to improve initial estimates. PRM is considered as a method that increases the achievability of project plans and a viable method to estimate contingencies on certain project elements. However in innovative projects, there will always be a large number of risks that are still completely unknown, which makes it very hard to provide accurate estimates in the conceptual phase of a project by solely using quantitative risk analysis methodology. It is therefore argued that reference class forecasting provides a strong method to complement PRM in making accurate project forecasts under uncertainty.

8.1.2 Defining group risk attitude or risk culture

Apart from psychological sources that cause our risk attitude, one might distinguish among different risk attitude levels. Each of these levels describes an alternative position adopted by people when faced with uncertainty. In fact, our "risk attitude" exist on a spectrum ranging from risk-aversion (uncomfortable with uncertainty), through risk-tolerant (no strong response), to risk-seeking (welcoming uncertainty), which can be seen from figure 55 (Hillson and Simon, 2007). In fact, there are many degrees and levels of risk attitude possible, although we generally use 4 common risk attitude labels:

- **Risk Averse:** Risk averse means holding a negative attitude towards risk, having a rather conservative risk attitude and a preference for secure payoffs. Risk averse people make good middle managers, administrators and engineers, as they are practical, accepting and support established methods of working. Hence they excel in activities involved in remembering, preserving and building.

- **Risk Seeking:** Risk seeking means holding a positive attitude towards risk, preferring speculating future payoffs. Risk seeking people make good entrepreneurs and negotiators, as they are adaptable, resourceful and not afraid of action. Hence they excel in activities that require performing, acting and taking risks.
- **Risk Neutral:** Risk neutral means a short-term risk aversion with a long-term willingness to seek risk, preferring future payoffs. Risk neutral people make good executives, system architects and group leaders as they think abstractly, creatively and are not afraid of change or the unknown. Risk-neutral people are good at learning, imagining and inventing.
- **Risk Tolerant:** Risk tolerant means that one does not have a strong response to risk. This might be expressed through active behavior (risk tolerant) or passive behavior (risk denial), see figure 55



In the same way that individuals have an attitude towards risk, we can find a different risk attitude among various groups, project teams, communities, countries and our business organizations (Hillson and Murray-Webster, 2008). Group risk attitude is often indicated with the term "risk culture", which reflects a group's common approach to uncertainty. Risk culture has a significant influence on the PRM process, for instance a risk averse culture can sometimes develop into risk denial. Having the feeling that there aren't any risks within the project, with as a result that decisions are made without considering the risks. While a risk-seeking organization make take on such an amount of risk exposure that is eventually exceeds its ability to manage it, quickly leading to a disaster.

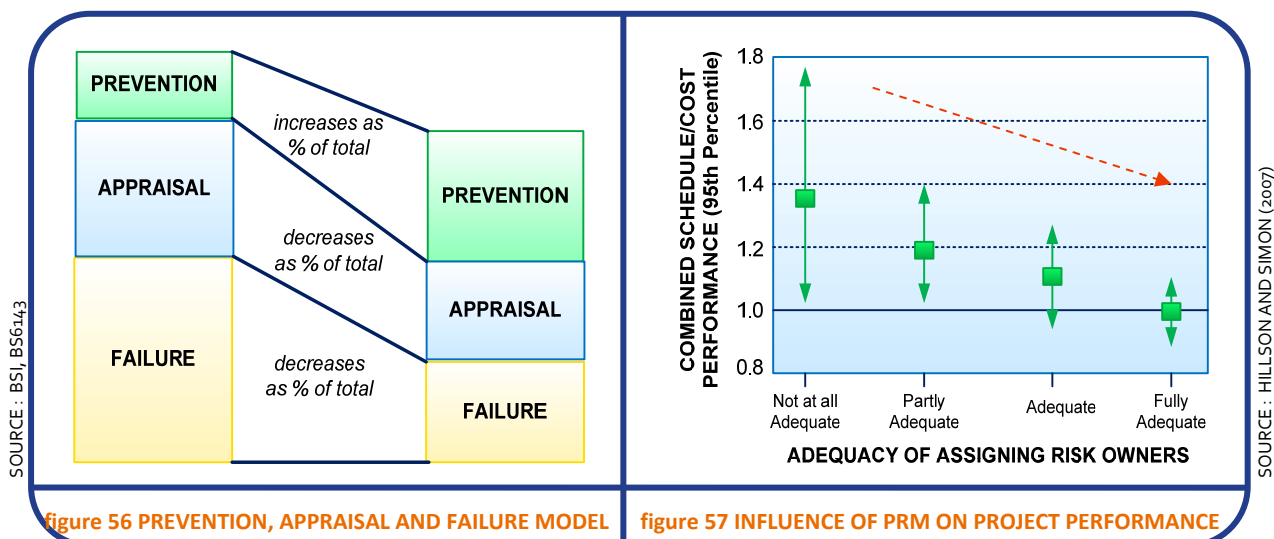
Generally, what is needed is a "risk mature" culture that is neither risk-averse nor risk-seeking. This culture recognizes that risks are inevitable and that effective PRM is essential. HMC however has taken on a lot of "high risk" projects (EPICs and EPRDs) and currently cuts many of its resources for the explicit management of project risk. This may imply a "risk-seeking" business culture that significantly affects the effectiveness of the PRM process in practice. Empirical results from a study within the engineering construction industry show that contractors share a "risk-taking" attitude (Lyons and Skitmore, 2004). During the case interviews, it was often indicated that HMC as an organization has a "CAN DO-mentality" which is crucial to the success of their core business, but might in some cases create an unrealistic stance towards risk (interview 6, 10, 11, 12 & 16, see appendix N). Hubbard (2009) explicitly addresses this issue in his book "The failure of risk management". Hubbard (2009) shows that for PRM to be effective, an organization should be aware of its "risk appetite" or "risk culture" to create a common awareness on the management of risk. With the use of calibration tests and workshop, it is possible to assess the position of an entire company on its tolerance towards risk (Hubbard, 2009). For HMC, it is argued to use these methods to create a better understanding of its appetite for risk in certain situations, thereby focusing on creating a balanced risk culture within the entire organization to increase PRM effectiveness.

8.2 Is PRM worth the investment?

One question often asked is if the costs of investing in PRM outweigh the perceived (financial) rewards. And if it is possible to somehow prove that explicit PRM will actually result in more successful projects. Terry Cooke-Davies (2005) indicates a current lack of evidence that can clearly points out the “*real value*” of risk management. One of the problems with managing risks is that every project is unique, so we can never know what would have happened if we did or did not implement a specific level of risk management. Hence, the evidence of the actual value of risk management within a single project is always inadequate and incomplete as there is no “*control group*” for comparison. However, it is possible to create a better “*proof*” of the cost efficiency of implementing an adequate risk management process if data is gathered over a variety of projects within different industries.

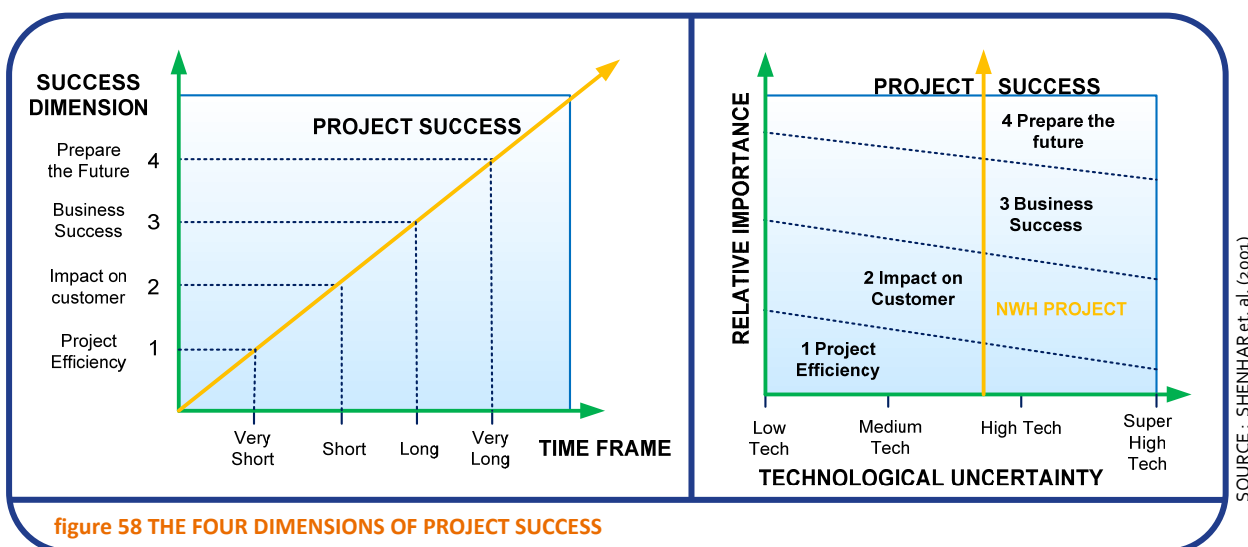
Current evidence for the claim that PRM makes a significant difference comes from the results of two project management benchmarking networks, the Europe 1 and 2 (Cooke-Davies, 2005). In these benchmarking activities, risk management practices have been examined on both the “*enterprise level*” and on the “*project-specific level*”, focusing on all four widely accepted stages of risk management; i.e. identification, analysis, management and control. Within each of these areas the implemented risk management approach has been analyzed on the overall procedure (what the manuals say should be done) and its application (what actually happens in practice). Focusing on the “*project-specific level*”, two studies have been carried out in 1996 (among 25 projects) and in 1998 (among 80 projects). The first study showed a significant difference of 45% in performance (cost, time, quality etc.) between projects that had effective PRM and those that didn’t. In the second study, there was a sufficient amount of data to indicate a positive correlation between the amount of risk management undertaken and the schedule/cost performance of the project (see figure 57). This showed that projects are completed on average at 95% of the initial plan when “*fully adequate*” risk management is implemented, in contrast to an average of 170% when risk management implementation is poor (Cooke-Davies, 2005).

Other evidence that supports the belief that PRM can create and protect business value (and that this can also be measured) comes from a parallel approach to proactive management in the area of operations (see figure 56). It is argued that the increased costs of prevention will eventually decrease the cost for appraisal (checking) and failure (Murray-Webster and Simon, 2007). Hence, monitoring prevention, appraisal and failure cost of PRM activities might demonstrate that it proves cost-effective in practice. For HMC, it is possible to draw an analog with their extensive safety risk management system. The rigorous application of a safety risk management process significantly decreased the amount of offshore incidents and injuries over time (Aven and Kristensen, 2004).



8.3 When is a project successful?

Next to discussing the factors that hold a significant influence on the effectiveness of the PRM process, we might also ask ourselves what we exactly mean with “project success”. One of the main arguments for implementing a PRM process is that it will improve the chance that a project meets its objectives, thus becomes successful. However “*project success*” means different things to different people. Shenhar et al. (2001) argues that project success should in fact be seen as a multidimensional strategic concept. There is far more to the common notion that projects are only successful when they meet their initial plans. Especially with long-term projects that experience a high level of technological uncertainty and complexity, the eventual success to the business as a whole might be more important than the efficiency of the project itself. This implies that what we perceive as “*project success*” varies according to time and the level of technological uncertainty. This changes the relative importance of four distinct project success dimensions (Shenhar et al., 2001): project efficiency, impact on the customer, direct business and organizational success and preparing for the future (see figure 58).



The idea of a multidimensional concept for project success explicitly came forward during the case study of the NWH project, which experienced significant overruns on both its schedule and cost estimates (see appendix L). When a fixed price is contractually agreed on a project where only broad requirements have been discussed at the start, cost and schedule estimates can be no more than guesses and the contractual agreements are little more than “best effort” promises (Murray-Webster and Simon, 2007). Accordingly, Project Managers are faced with the complex challenge of delivering a project on time, within budget and keeping the project staff and client happy while at the same time not knowing what actual work is to be done and to which requirements. In a situation where the scope and strategy of the project are constantly changing while the deterministic project duration and budget remains the same, it is no longer possible to distinct success from failure by solely looking at the project’s performance on time and costs (Shenhar et al., 2001).

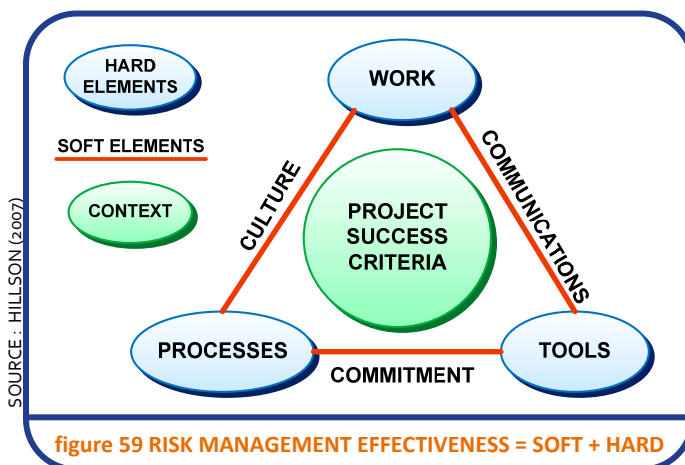
Murray-Webster and Simon (2007) indicate that for these seemingly impossible projects, it is far more important to focus on the people to make sure that there is a willingness to work together. This creates a relationship between the contractor and the client that would transcend delay and problems into the development of a trusting partnership, rather than having a daily struggle over the contract resulting in a variety of legal disputes. This can also be seen in the NWH project, because while the project might have been a financial setback for HMC, it was seen as very successful by the client (Interview 26, see appendix N). Consequently, the client might insist to work with HMC in the future which might eventually create a range of new business opportunities. This illustrated the

tension between project success and business success. Because a high-tech and innovative project will be mainly assessed on its long-term effects, rather than the short-term concerns of meeting time and budget performance. A possible disadvantage of an extensive PRM process is that in many cases it focuses on keeping the project to its cost and schedule objectives. For some projects, the means to achieve these objectives and manage all project risks might be in conflict with the more intangible business objectives. Hillson (2006) therefore indicates that what is actually needed is an *integrated risk management* process that addresses the risks across a variety of levels in the organization. Development in the field of PRM should focus on closing the gap between strategic vision and the way we define our project objectives, making sure that the PRM process not solely focuses its attention on the threats to the achievement of project time and cost estimates, but also incorporates the opportunities to the business as a whole.

8.4 The human dimension of PRM

As discussed in the previous section, one of the most important elements for effective PRM is often lacking: an appropriate and mature risk culture. PRM is always performed by people who on their turn form a part in a variety of different groups. So in fact, the human element introduces another dimension of complexity into the PRM process. It is important that one is aware of individual, group or corporate risk attitude that causes ineffective PRM. But apart from changing our attitude towards risk in general, we might also adopt various unwelcome perspectives towards the PRM process itself. Project managers often indicate that the management of threats and opportunities is just common sense, and that an extensive PRM is only time-consuming, costly and ineffective (Murray-Webster and Simon, 2007). Consequently, there are a number of common excuses that hamper the effective implementation and application of a PRM process (Simon, 2007).

Hillson (2009) indicates that the theory, tools, techniques and training for risk management can only be effective if they are joined by the right communications, commitments and culture (see figure 59). Because what really separates "best practice" PRM from the approach described in theoretical handbooks and guidelines is the ability of an organization to put all the knowledge, skills and techniques into the context of the organization and the people within it. It is argued that effective PRM needs leadership and a *"strong, influential and positive role model for adopting risk management practices"* (Murray Webster and Simon, 2007).



- **Culture:** Demonstrating a set of values, attitudes and behaviours that respond appropriately to risk. Taking the right levels of risk and making risk-aware decisions at all levels of the organization.
- **Competence:** Everybody should have the knowledge, skills and experience to recognize and manage risk at their level of responsibility.
- **Commitment:** Risk information must be used to inform decisions across the organization. Everyone should be committed to respond appropriately to uncertainty.

This thesis mainly focused on the theory, tools and PRM process and how these might be improved to better cope with risks in EPRD projects. However, what is needed next to a change in PRM tools and techniques is a shared understanding of the key concepts and principles of PRM, and their importance to successful projects (and businesses). Continuous training on PRM principles is required to develop a common language and understanding. PRM therefore requires the combination of hard and soft elements to ensure its effectiveness in practice.

8.5 Implications of “soft aspects” for implementing thesis recommendations

This thesis project focused on developing an approach for the improvement of HMC PRM to cope with complex EPRD projects. Accordingly, a number of recommendations and quick wins have been identified from comparing HMC’s current PRM practice with the ATOM methodology which is considered as the current best practices in the field of PRM. However, it can be concluded from the analysis set out in this chapter that there are also a number of “soft aspects” that influence the effective implementation of PRM processes, tools and techniques.

For PRM to be effective, it should become a central part of the culture and practice of HMC, which is something far more difficult to achieve. The organization as a whole should recognize the importance of managing risks for the success of all projects. Without the collective will to invest in PRM, the process will quickly lose its effectiveness in practice.

During the thesis evaluation session it was recognized that some of the thesis recommendations could be implemented rather easily, while others would require far more effort and time. Accordingly, a distinction has been made between those “quick wins” that can be implemented almost immediately; focusing on adapting the tools used in the current HMC PRM process. Next, there are several recommendations that require additional effort and time for their development, but can be implemented in a period less than 6 months. These are the recommendations that concern a change in the overall PRM process or the inclusion of additional techniques and process elements. Finally, there are recommendations that require a cultural change that takes place over a longer period of time and requires additional efforts. Accordingly, an implementations path is constructed for the implementation of the thesis’s “quick wins” set out in chapter 7, taking both the hard and soft elements of PRM into consideration.

8.5.1 Short-term changes to PRM tools – Risk Workshop and Risk review

A number of elements identified in this thesis can quickly improve the effectiveness of the current PRM process that is applied at HMC, focusing on adapting the tools and techniques used for risk identification, assessment and control. An important element in the risk process is the risk workshop, for which a number of improvements have been identified in chapter 7. As HCM is used to identify and assess risk in a risk workshop, changing some of its elements can quickly enhance the effectiveness of the PRM process as whole. The following recommendations are selected that can be implemented almost immediately to enhance the effectiveness of the HMC risk workshop:

- **Increase workshop duration from 1-3 hours to 1-2 days:** Complex EPRD projects require more time to effectively identify and assess all risks. Increasing the workshop duration allows the inclusions of additional elements for effective risk identification and assessment.
- **Perform pre-workshop activities:** Providing attendees with some preliminary reading on the project’s case and scope allows the risk workshop to get off to a flying start. If attendees identify their five biggest threats and opportunities before attending the risk workshop will be more effective.
- **Use checklist and RBS to trigger risk identification:** The use of a RBS and common risk checklists that are widely available can trigger people to think “out-of-the-box” and identify additional risks.
- **Categorize risks:** If the workshop’s duration is increased, it becomes possible to include a specific step to categorize risks on a predefined RBS and the project’s WBS. This makes it easier to take out risk duplicates, rationalize on risk sources/effects and to effectively allocate risk responsibility.
- **Using effective tools for risk prioritization:** The current PI matrix can easily be changed to best practice standards for effective risk assessment. It is recommended to use specific PI scales for various project objectives to separate different effects of a single risk.
- **Change meta-language to describe risks:** By simply changing the definition of risks used in the current PRM process and risk registers it becomes possible to create clarity on the perceived source and effect of each risk and therefore improve the possibility to identify effective risk response.
- **Nominate single risk owner for each risk:** There can only be one person responsible for the management of each risk, which in many cases is not the project manager. It is therefore important to explicitly allocate each risk to a single risk owner during the risk workshop.

Next, there are a number of recommendations that can be implemented on a relative short term that might easily improve the implementation of risk responses and actions. The following recommendations are selected that can quickly enhance the effectiveness of risk response implementation in the current HMC PRM process:

- **Review all red risks and their planned responses in PSR meetings:** Currently, only the top 10 risks of a project are discussed during a PSR meeting, but there is only little focus on the effect of planned and implemented responses. Explicitly checking all red risks and their responses would significantly increase the use and application of the current PRM process in practice.
- **Plan major review meetings at start of every project phase:** In EPRD projects, there are several distinct phases for which a major risk review is required. Organizing a major risk review workshop at the start of each project phase will ensure the risk register remains active and up-to-date.
- **Include additional information on risk status and response actions:** Simply adding a few columns to the risk register that record the current risk status, date and reason of exclusions and the date the risk has been raised create an important change log that can be used to evaluate the effectiveness of the PRM process. The same can be done for actions, including information on the action status, date of implementations and costs of the response in the risk register.

8.5.2 Mid-term change to PRM process – Pilot application and Risk Sponsor

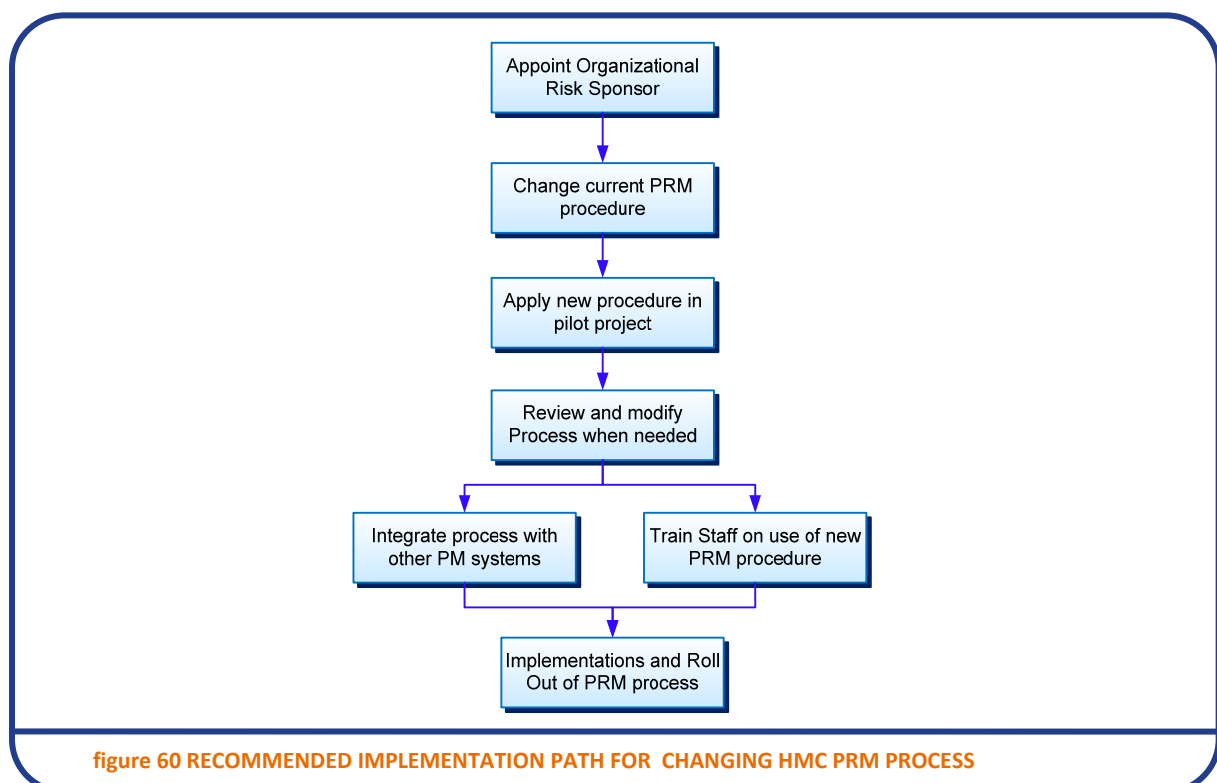
Apart from changing the current tools that are applied in the HMC PRM process, chapter 7 has argued that a number of additional elements and steps are needed to increase the effectiveness of the PRM process. However, changing a common management procedure takes more time than simply changing its already present tools. Accordingly, a number of recommendations have been identified that can be implemented in a period of approximately six months:

- **Development of project-specific RMP:** One of the important recommendations made in chapter 7 is to vary the entire PRM approach to fit the perceived risk profile of the project. Accordingly, a specific procedure or template should be developed for a project-specific Risk Management Plan. Such a plan should clearly describe the scope, tools, techniques, activities, responsibilities, reporting requirements and scales that are used in the RMP process. Varying the PRM approach and techniques used in for instance the risk workshops contributes to the effectiveness of PRM in practice.
- **Include stakeholder analysis in PRM process:** A stakeholder analysis is critical in complex projects to make sure all important parties are included in the PRM process. A specific tool or process to make up a project's stakeholder list should be developed and included in the current PRM procedure.
- **Including explicit PRM initiation meeting:** One of the requirements of an effective PRM process is to discuss and agree with all project parties on the project's objectives and required level of risk management implementation. An initiation meeting functions as the means to create clarity and openness among all project parties, to support a collective responsibility for managing risk throughout the entire project lifecycle. It should therefore also be decided who should take part in the risk meetings, workshops and other elements that affect PRM.
- **Integrate added value sessions with PRM process:** The PRM process should have a similar focus on threats as on opportunities. It is therefore recommended to integrate the added value sessions with the risk workshop, to ensure both threats and opportunities are managed by the same system.
- **Hold interviews with risk owners to determine and report on risk responses and actions:** The current HMC risk process lacks an explicit step for the development of risk responses and actions. A procedure for developing risk responses and their respective actions, costs, resources etc. should be developed and integrated with the current PRM process. It is suggested to use interviews with the project's risk owners to develop specific actions to the identified risks and document these in the risk register.
- **Capture Risk Knowledge at end of the project:** In chapter 7, it has been recommended to integrate a post-project risk review sessions with the current lessons learned sessions that HMC undertakes. Risks that have occurred can be added to a common risk database. Next, it is recommended to evaluate the overall PRM approach and application of the process throughout the project lifecycle to identify its effectiveness in managing risk and ensure a continuous improvement of the overall PRM procedure.

For the successful change of the current HMC PRM process and the inclusion of additional elements that requires time and resources of the entire organization is crucial that there is enough support throughout the entire organization. It is not possible to simply change the current procedure and assume that everyone will immediately adhere to its contents. It is therefore recommended to appoint an *organizational risk sponsor* to lead the improvement of the risk management process into the company (see figure 60). This should be a senior manager with broad experience across the entire organization, which is respected at all levels, having sufficient knowledge of the risk process and a clear vision of the place of PRM at HMC.

Next, a phased implementation process is desired to create commitment across the organization to implement necessary changes, making sure that everybody engages and cooperates to this initiative. The recommended process changes described in this thesis can form the starting point for this process of change; however it is up to the management of HMC to decide which recommendations are actually implemented. The first task of the organizational risk sponsor is to change the current PRM procedure and develop effective guidelines and templates for the additional steps that are currently lacking. Next, it is recommended to apply the new procedure on a *pilot project* so the process can be refined in the light of practical experience. It is important that all stakeholders are committed to the application of the newly develop PRM process, and that it is adequately embedded in other PM systems.

After the pilot application, a review meeting should be organized to evaluate the newly designed PRM process and its perceived effectiveness. Issues, problems and opinions from the people that have used the new procedure should be taken into account to further develop and improve the PRM process. Next, the procedure can be rolled out and implemented across the entire organization, led and supported by the organizational risk sponsor. A structured campaign for effective communication is recommended, as well as the training of personnel to become familiar with the new techniques and changes to the current procedure. Effective implementation of the PRM process requires sustained education of all, the emergence of internal role models, strong leadership and a supportive organization.



8.5.3 Long-term change to PRM culture – Communication, Commitment & Competence

As discussed in this chapter, one can change the tools, techniques and process for effective PRM (hard elements) however these are only effective if PRM becomes part of the company's culture and the way people think and act. A number of recommendations identified in chapter 7 can therefore not be implemented easily, but will have to be part of a change program taking place over a longer period of time. The following recommendations are therefore will therefore require an implementation period of several years until it becomes a cultural imperative of all:

- **Adequate use of range estimates in schedule and cost forecasting:** The conscious and subconscious factors that influence project forecasts and estimates can be minimized by using range estimates in project schedules and plans. People give a far more accurate estimate if they are asked to give three-point estimates. However as Murray-Webster and Simon (2007) indicate that we are naturally "driven to precision" as it is in most cases considered cultural unacceptable to provide range estimates. Reference class forecasting might be an alternative method to increase cost forecasts, however to create confidence in such a method requires a change of culture.
- **Use of schedule-based quantitative analysis:** Quantitative Risk Analysis is considered to be a strong method for the development of realistic plans, budgets and to compare alternative decisions. However developing a realistic QRA model and keeping it up to date requires a lot of effort. For QRA to be valid and effective, it should be integrated with the project particular schedule and network structure, which requires additional effort. QRA analysis can only succeed when the qualitative PRM process is fully embedded in the company's organizational culture.
- **Allocate risk responsibility to the project's sub-teams:** Effective PRM requires a collective responsibility on the management of risk throughout the entire organization. Accordingly, each sub-team should manage its own risks using PRM methods, so that PRM becomes integrated in the project's organization instead of controlled by the project's manager. This however requires a change in overall management culture which is expected to take place over a longer period of time.

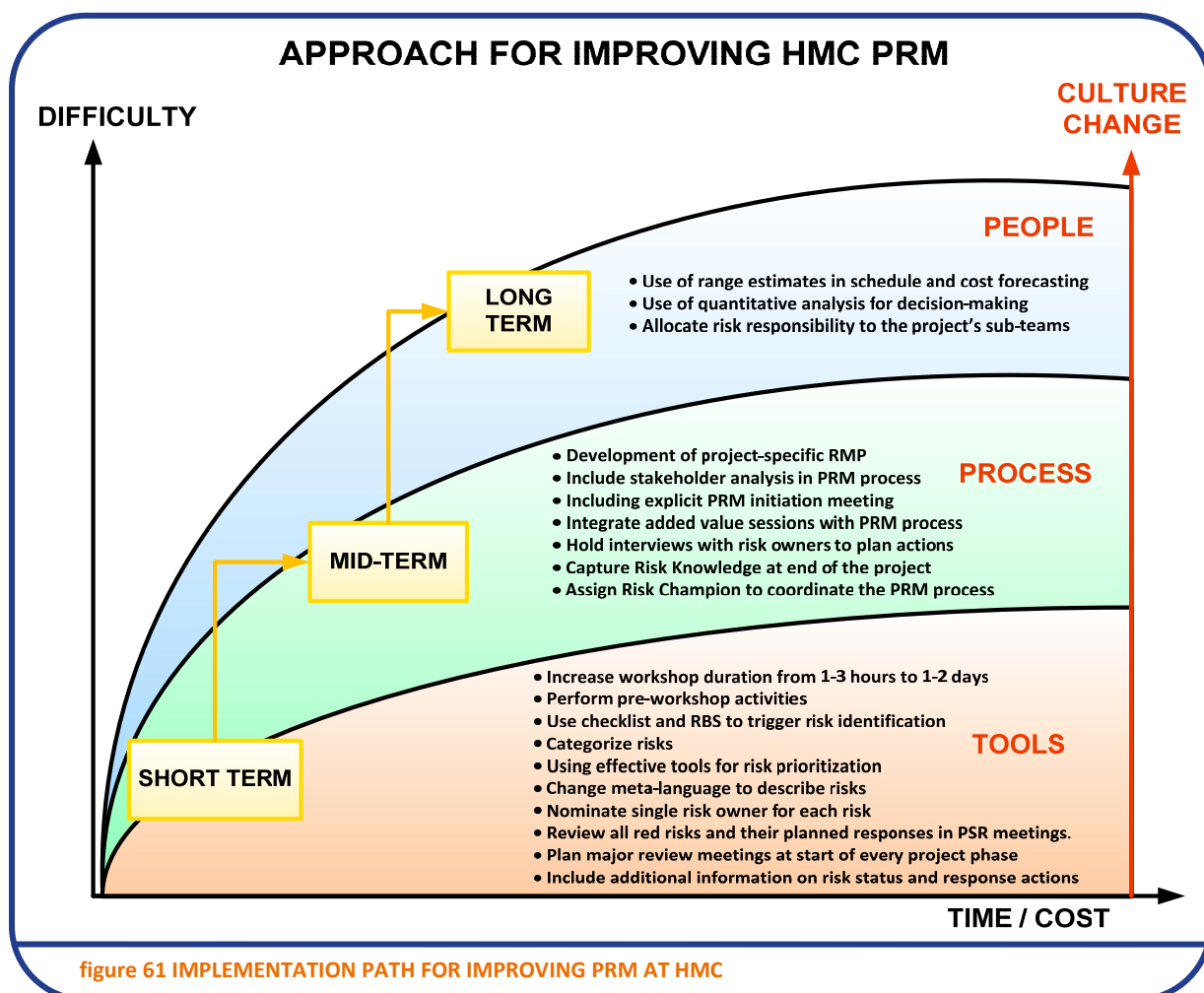
Hillson (2009) indicates that the theory, tools, techniques and training for risk management can only be effective if they are joined by the right communications, commitments and culture (see figure 59). It is argued that effective PRM needs extensive leadership and a "*strong, influential and positive role model for adopting risk management practices*" (Murray Webster and Simon, 2007). On the long run, a change of the company culture requires support from top management within the HMC organization. PRM requires explicit drivers to become effective, making sure that people are encouraged to actively take part in the PRM process. A mature risk management culture makes all the difference to ensure the effective implementation of the recommendations set out in this thesis. To build such a culture, managers, risk champions and HMC top management should drive and propagate the application of PRM in practice:

- **Top Management:** Acknowledge the effects of risks on project outcomes and provide the necessary resources and support to manage these risks proactively. Reward people and project manager that effectively apply PRM in practice. Integrate risk management at both operational and strategic levels.
- **Project Manager:** Make PRM a daily exercise and use the language of PRM in the communication with project members and stakeholders. Don't restrict the management of risk to the specific risk workshops and meetings but continuously talk to people about their uncertainties and perceived risks. Show that PRM matters in the way it is addresses through the entire project lifecycle and encourage people to actively take part in the process. Find ways to continuously build risk knowledge in the project's plans and strategy and to improve the organization's skill to cope with change.
- **Risk champion:** Support, facilitate and drive the management of risk and application of the PRM process throughout the entire project lifecycle. Motivate risk owners and the project team to continuously identify and assess risks and implement specific actions and responses proactively. Show the effectiveness of the risk process by comparing pre- and post-response levels and make sure that the barriers that hamper effective PRM are overcome. Provide guidance during the application of PRM and make sure the process remains exciting to all.

8.5.4 Approach for improving PRM at HMC

While the analysis and creation of improvements to the current PRM approach of HMC has been a major undertaking, the actual implementation of changes within the company's organization is considered to be far more challenging. The acceptance, commitment and confidence of people in an explicit PRM process is critical to its success in practice, this poses the challenge of how to implement best practice PRM in a way that allows it to become an integral part of the company's culture. Ultimately, the success of PRM depends on people changing their behaviour in the face of risk which is very difficult to achieve.

In this chapter, it has been argued to use a phased approach to the implementation of recommendations set out in chapter 7 (see figure 61). On the short term, minor changes to the tools and techniques that are currently applied can be made to increase the effectiveness of the HMC PRM process. Spending more time on the identifying, assessing, rationalizing, categorizing, prioritizing and dividing risks in the risk workshop can significantly improve PRM in complex EPRD projects. Furthermore, there need to explicit checks of the changes to risks and the implementations of responses and actions to manage these risks as the project proceeds. Secondly, it has been argued to appoint an organizational risk sponsor that should further develop the suggested changes to the overall PRM process set out in this thesis. Specific guidelines, templates and procedures need to be developed to scale PRM, create adequate controls and capture risk knowledge. It is desired to first apply the changes to the PRM procedure on a pilot project before it is rolled out over the entire company. Finally, there are some recommendations made that require a collective change of organizational culture to treat risk and uncertainty differently. Competent people, strong leadership and top management commitment are essential to ensure PRM effectiveness in practice.



9

Chapter

"Taking active steps to reduce the possible effects of risks is not indicative of pessimism, but is a positive indication of good project management"

Robert Buttrick

"Risk management is too important to be left to chance"

David Hillson

9.1 Conclusions

9.2 Recommendations

9. Thesis Conclusions



This chapter gives an overview of the most important conclusions of the thesis, which focused on developing an approach for the improvement of the current HMC PRM process to cope with uncertainty and risk in complex EPRD projects. First, the challenges HMC currently faces are summarized as well as the chosen approach to answer the thesis research question. Next, the thesis results that underpin the answer to this research question are given. Finally, recommendations for the improvement of PRM within HMC are defined.

9.1 Conclusions

9.1.1 Challenges for HMC

HMC is widely recognized as one of the world's leading companies in offshore transportation, installation and removal. A large part of the company's excellent reputation stems from its ability to constantly respond to changing industry needs, market dynamics and its competitors. However more recent trends in the offshore industry cause HMC to appeal to their adaptive ability more than ever as they are challenged by projects with a different risk profile, e.g. EPRD projects. In these projects, HMC takes on the role of main contractor for a much larger scope of work, illustrating the recent shift of risk responsibility from client to contractor. In addition, the worldwide economic crisis and the fact that HMC's vessels are nearing the end of their productive lifecycle emphasize the need to improve their ability to cope with uncertainty.

These developments have elevated the importance of a relative new and promising market area to HMC: the offshore removal market. At present, removals are of particular interest to HMC because the company acquired the NWH and Ekofisk EPRD projects in 2006/2007. However, the success of these projects is subjected to many risks, stemming from the fact that the entire industry is still relatively inexperienced when it comes to the removal of the large fixed platforms located in the North Sea. Moreover, the responsibility that HMC has in current EPRD projects as the project's main contractor clearly sets the tough challenge that HMC faces in the coming years.

To proactively manage its risks, HMC has been using a formal PRM procedure for the past three years. But there is still little known of the contribution of this process to the effective management of risks in practice. Consequently, this thesis focuses on the analysis of PRM at HMC and the improvement thereof to better cope with the high risk profile of EPRD projects. It is argued that a review of the PRM process applied to current EPRD projects is desired in the light of the current and future challenges HMC faces.

9.1.2 Research question

The aim of this thesis is to bring the knowledge of PRM and the application thereof to an adequate level for managing risk in complex EPRD projects. Therefore the thesis explores the HMC PRM process in the context of current best practice standards for managing project risk. This will create a better insight into the effectiveness of HMC's current approach as well as the identification of possible improvements to better cope with the risks in EPRD projects. Accordingly, the thesis research question is:

How can the current HMC project risk management process be improved to best practice standards to cope with project risks & uncertainties in complex EPRD projects?

9.1.3 Research approach

To answer the thesis research question, the design science paradigm is chosen as it concentrates on changing existing systems, either by improving or by creating entirely new systems. In a sense, design science combines both the interpretive (soft) and analytical (hard) paradigms in a system's approach for the creation of knowledge (Van Aken, 2004). Pollack (2005) indicates that the conventional project management paradigm (hard paradigm) is changing, as complex and uncertain situations require a "softer" approach that addresses the ability of people to effectively work together. Hence, for the improvement of PRM, a more pragmatic and solution-oriented approach is desired. Design science fits this prescription as reality is explored through constructive intervention, thereby integrating both "systematic" and "people" necessities for success in a complex and dynamic environment.

Within the chosen research paradigm, the intervention cycle of Verschuren and Doorewaard (2005) has been selected. This approach can be seen as a multi-methodology, combining and partitioning parts from different research paradigms (Mingers and Brocklesby). The first part of this cycle consists of exploration-oriented research (exploring and diagnosing the problem and creating awareness), after which the research shifts to a more development-oriented research perspective (designing and evaluating the solution to the problem). Accordingly, the research performed in this thesis is divided into three parts; e.g. *Orientation, Exploration and Development*.

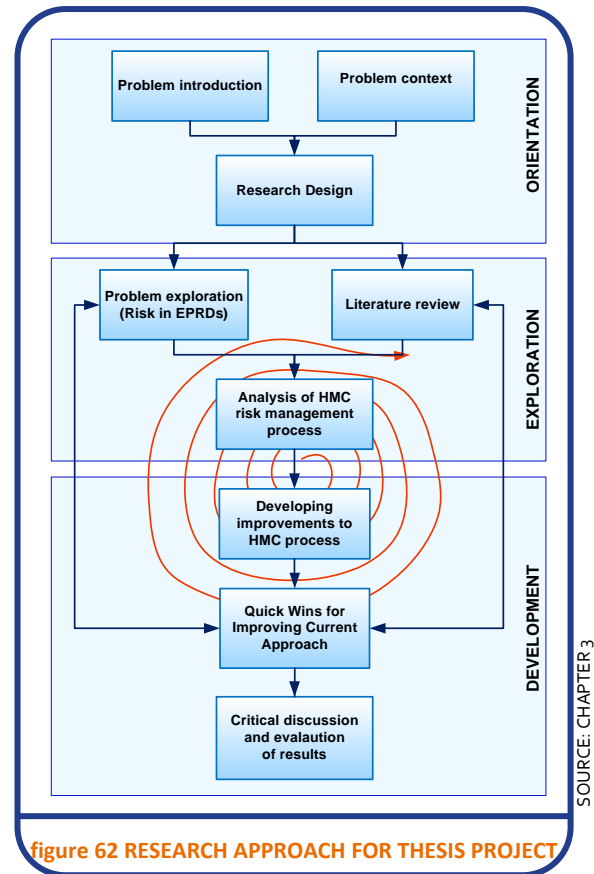
During the orientation phase, the research problem, context and objectives are specified. An overview of the removal market is given in the light of the HMC's expertise and experience as a marine heavy lifter. HMC finds itself at the start of the learning curve when it comes to the removal of the large steel jackets located in the Northern North Sea. Results from an extensive literature review on the current removal market are discussed, providing background information on the topic of research as well as creating awareness of the challenges HMC faces in the foreseeable future.

The explorative phase of the thesis focuses on the analysis of the problem situation. Information is gathered within the interpretative research paradigm, creating insight in- and overview of the uncertainty and risks in current EPRD projects as well as the process used for the management of these risks. Case study research is selected to gather information in a coherent matter, providing a multi-sided view of the situation in its real-life context (Perry, 1998). What is perceived to be risky, and which risks really matter is highly dependent upon the time of investigation and the person asked. Risk is a multidisciplinary and contextual concept, which makes it very challenging to induce a general perspective of the main drivers of risk in EPRD projects, as well as creating an understanding of the application of the HMC PRM process in practice. To address these issues and rule out project specific bias, a multiple-case study is chosen as the desired approach for which both the NWH (2008/2009) and Ekofisk EPRD (2009/20014) projects have been analyzed. Multiple sources of data are used in order to triangulate information, combining the findings from interviews, desk research, project-specific documents, system manuals and literature. Reflective interviews have been held with HMC experts to validate the initial conclusions and findings from the case study.

The explorative phase of the thesis can be divided into three subparts (see figure 62):

1. Exploring the risks and complexities associated with large EPRD projects from the perspective of HMC. Creating knowledge of the need and difficulty of managing risk in these kind of projects, which poses specific requirements to the PRM process
2. Exploring and reviewing literature on the subject of PRM to create an overview of the methodological principles of managing risk, as well as assessing the current “best practice” PRM process.
3. Exploring the current HMC PRM process in comparison to best practices from literature, making it possible to identify possible improvements. Based on case study findings, the PRM process of HMC has been mapped and the application of this process in practice has been discussed and evaluated.

Finally, the developmental phase of the thesis focuses on designing an approach for improving the HMC PRM process. Eleven “quick wins” have been identified from literature, focusing tools and techniques within this PRM process. The identified quick wins have been evaluated in an interactive session with HMC management.



9.1.4 Thesis Conclusions

To answer the research question, first the sub research questions are briefly answered to give insight into the composition of the answer to the research question.

Which uncertainties and risks affect the management of EPRD projects?

Together, the structural complexity, uniqueness and dynamics of EPRD projects cause managerial complexity of the project as a whole, reducing the manager’s ability to predict, control and measure the outcome of the project. Hence the uncertainty and risks affecting the performance of EPRD projects mainly stem from:

- **Less predictability:** The industry’s lack of experience in the decommissioning of the larger fixed platforms in the North Sea challenges the *predictability* of EPRD project. New concepts, processes and technologies are needed for the removal of the larger platforms because they were not initially designed for that purpose. It can be very hard to obtain the necessary information on the structural integrity, contamination and deteriorated state of the platform. This not only makes it hard to make solid assumptions in advance, but also sketches the dynamics that affect the project under execution. Technological innovations and their interactions hereby increase uncertainty within the project.
- **Less controllability:** The fragmentation of technology and the inherent dynamics of EPRD projects reduce their controllability from a manager’s perspective. The many subsystems and processes performed by other parties under the control of HMC. The fragmentation of both the internal and external project organization reduces the ability to maintain control. Success in EPRD projects for HMC depends for a great deal on the cooperation and performance of its subcontractors.
- **Less Measurability:** The size of the project, increased complexity and a large project organization reduce the measurability of the project’s status. Due to large scope of EPRD projects, it is more difficult to keep track of all the processes and developments that take place. Diverging interest between different projects parties further decreases the ability of a project manager to maintain oversight of the project as a whole.

In addition, there is a shift in risk balance between the client and contractor which causes a heightened risk responsibility for HMC in removals compared to installation projects. Removal projects are nonproductive and therefore cost-driven instead of time-driven. As a consequence, the client is more interested in getting a low price and maintaining its reputation rather than that the project strictly adheres to previously set deadlines. As a result, the focus of the client and contractor become conflicting, as the client focuses on extensive requirements to ensure a safe and sound removal, while HMC is faced with the challenge to keep the project within a predefined budget and schedule. In removal project the client does not have a direct financial interest in the “result” of the project, thus he will be prone to shift risks as much as possible to the contractor.

Why is project risk management important in EPRD projects?

The most important reason for explicit PRM in EPRD projects is because it significantly increases the chance of project success. PRM optimizes the probability that the project stays within the budgeted costs, the allocated time period and the acceptance of the client. The PRM process focuses on identifying and understanding the uncertainties and risks that really matter to the project as a whole, creating a common understanding among all project parties of their existence and proactively managing their implications to increase the chance of project success. Where the management of risk is ineffective, a project can only succeed if the project team is lucky. However effective PRM optimizes the chances of the project succeeding as planned, even in the face of bad luck.

What is the required level of PRM implementation for EPRD projects?

The shift in risk responsibility and large project scope of EPRD projects for HMC creates the need for more explicit risk management activities. Transparency of risks is crucial to create mutual responsibility and commitment among all project parties and stakeholders. The organizational complexity of EPRD projects demands a collective responsibility on risks, as it is no longer possible for a single project manager to oversee, coordinate and control all the risks that affect the project. The inherent uniqueness and dynamics of EPRD projects indicate the need for a continuous collaboration on risks along the entire project lifecycle. Proactive identification and management of risks is required from all project stakeholders. Furthermore, the structural uncertainty and risk responsibility for HMC within EPRD projects require the acknowledgement of risks in schedules and budgets, to ensure there is enough flexibility to cope with changes as the project proceeds.

What is “best practice” project risk management?

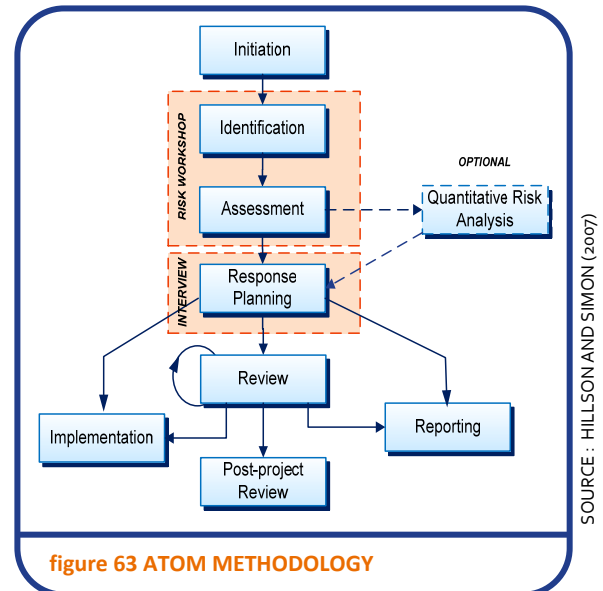
“Best Practice” PRM consist of the most *efficient* and *effective* way of managing project risk, based on repeatable procedures that have proven themselves over time for a large number of people (Hillson, 2004). It is about the routine activities that lead to excellence, and are widely accepted and supported by leading professionals and practitioners. Not “*what everyone does*”, but “*what everyone should do*”. Accordingly, “best practice” is considered with the definition of “*Project Risk*” and the specific components that make up the “*Risk Management Process*”.

1. **Project Risk:** “*An uncertain event that, if it occurs, has an effect on project objectives*”.
Current best practice within the field of PRM adopts a broad view on risk that includes both the positive and negative effects of uncertainty. Consequently, risk can form either a threat or an opportunity to the (successful) realization of the project. Furthermore, risk should be seen separate from uncertainty, because a risk has a certain probability and impact that makes it possible to quantify the risk. Thus, a risk is defined as an event that might take place somewhere in the future, with a certain cause (uncertainty) and effect on project objectives.
2. **Project Risk Management Process:** “*process for the systematic management of project risks*”.
Within this process, several steps, tools and techniques will help the project manager to maximize the chance of meeting project objective in the face of uncertainty. “Best practice” implies that the risk management process itself should include explicit steps to ensure that PRM remains under control, promoting a continuous review and reassessment of project risks and response plans. This ensures that the process is adequately controlled, reviewed, communicated and reported upon.

What does the process of project risk management look like?

Within the thesis project, 17 PRM standards and guidelines have been selected and reviewed, developed by both international standardization bodies and professional organizations that have an interest in risk management. The approach that best suits the description of best practice is the “Active Threat and Opportunity Management” or ATOM- methodology developed by Hillson and Simon (2007). This methodology addresses both threats and opportunities, bringing together a variety of tried-and-tested methods, tools and techniques into a simple and scalable process that is made up out of eight successive steps (see figure 63):

1. **Initiation:** Discuss risk profile of the project in an initiation meeting to determine the required level of RM implementation.
2. **Identification:** Identify and describe all risks during a risk workshop, including both threats and opportunities.
3. **Assessment:** Use both Qualitative and Quantitative techniques to assess risks on their relative importance.
4. **Response Planning:** Develop adequate response plans, actions and contingencies to manage risks proactively.
5. **Reporting:** Report all risk information and actions in a risk register and create effective communication to all.
6. **Implementation:** The continuous Implementation of responses via their associated actions to change the project's risk profile.
7. **Review:** Review the project's risk profile to assess new risks, risk changes and check the effect of implemented actions.
8. **Post-project Review:** Discuss and report the “risk lessons learned” which provide important input for future projects.



What does the current HMC process for project risk management look like?

HMC uses the same risk procedure for all of their tenders and projects, which is facilitated by a risk coordinator within the legal department. The process starts with a single risk workshop of approximately three hours in which all project/tender risks are identified, assessed and mitigated. During the workshop, risks (both threats and opportunities) are identified using a phased brainstorm. Next, the risks are described and assessed in small groups on a qualitative scale for both probability and impact. Finally, initial mitigation actions are identified and a specific person or department is tasked to implement these actions. The risk information generated during the workshop is entered in a risk register which is developed and maintained by the risk coordinator.

For every tender and project, HMC uses a pre-developed Monte Carlo model to analyze the overall risk level on two dimensions: the project's offshore duration and financial result. After the risk workshop, the respective project/tender manager and the project controller quantify the most important risks by specifying a certain probability distribution and perceived risk impact (in whole vessel days). Next, the risk model uses a spreadsheet model to calculate the overall “risk footprint”, a scatter plot of possible project outcomes from the simulation. The output of the quantitative analysis is defined in terms of the P10, P50 and P90 probability of the project's offshore duration and financial result compared to the most recent project forecast.

At HMC, risk information is communicated through the risk register, which is distributed and controlled by the projects manager. The risk mitigation measures or actions are instigated, monitored and controlled by the project manager as well, who is fully responsible for managing all project risks. In compliance with the risk coordinator, the project manager regularly updates the risk register and reports the top 10 risks during internal project progress meetings.

How is the HMC process for project risk management applied in current EPRD projects?

In the EPRD projects that have been analyzed in the thesis case study, the general HMC procedure for the management of project risk has been applied. However it can be concluded that the same procedure is in fact applied twice, once in the tender phase and then starting all over again when the project is awarded to HMC. As there is no explicit handover of the tender risk register, it remains unclear which risks have been managed proactively and have been included in the project's budget, schedule, strategy and contract structure. It can be seen from the NWH project that the project's scope and tender bid included many uncertainties, for which there were no contingencies or specific risk treatments implemented.

The HMC risk workshops focuses on identifying both threats and opportunities, however the EPRD risk register shows that less than 10% of the 120 identified risks were in fact opportunities. This indicates the tendency to perceive risk negatively. People more easily associate risk with a potential hazard instead of an uncertain event that might be beneficial to the project's outcome. Next, it can be concluded that during the EPRD risk workshops, almost 40% of the risks were indicated as "high" and 50% as "medium". This clearly shows the heightened risk profile of these projects and the many uncertainties that affect the project's objectives. Furthermore, almost 25% of the risks in EPRD project stemmed from subcontractors. However these subcontractors were not included in the PRM procedure, neither were there specific actions to manage subcontractor risks. Generally, less than 50% of the risks in the risk register had an explicit and documented response for their management. However most of these responses are very cryptic and vague, giving no clear implications of whom, why, how and by what means the project's risks are addressed proactively.

Like with all HMC's projects, the project's manager is responsible for developing, implementing and monitoring the implementation of risk responses. Thus, it remains unclear which actions have been developed and if they actually have been implemented. The current process does not explicitly check and monitor the implementation and development of risk responses, neither is it clear why risks are excluded from the risk register. The HMC PRM procedure explicitly identifies and analyzes risks, but does not contain the necessary means to make sure that these risks are actually managed in practice.

FINAL THESIS CONCLUSION

Firstly, it can be concluded that HMC applies the same risk procedure to all projects with only little variation. This implies that for the more "simple" project the process is perceived as "bureaucratic", while for the more complex and high-risk projects far more resources, efforts and rigorous controls are required to effectively manage the project's risks. It can be concluded that there is a significant difference between risks in the more conventional T&I projects compared to the complex EPRD projects. Accordingly, what is missing in the current PRM procedure is a project-specific approach. Best Practice PRM prescribes to explicitly discuss and review a project's risk profile, to determine the required focus and level of PRM application that fits the perceived level of risk within the project.

Secondly, there are many differences between the tools and techniques applied in the HMC's risk workshop compared to what is considered best practice. The current risk workshop takes only three hours, while for the effective identification and assessment of risk in an extensive EPRD project one might need a minimum of two days. The current workshop focuses on gathering as much risk information as possible, rather than making sure that all important stakeholders discuss, agree and collaborate on the project's risks so the gathered information is of a sufficient quality to allow effective responses. It can be concluded that the workshop lacks the means to stimulate "out-of-the-box" thinking, and there is only little time spent on the rationalization, categorization and allocation of risks. If there is no clarity on the relative importance of risks and who should take responsibility for their management, reality teaches us that in many cases nobody does. It is therefore important to explicitly assigning each risk to single individual that is considered to be the best risk owner.

Thirdly, HCM applies quantitative risk analysis to all of its tenders and projects. However the model used does not reflect the specific subsystems and interactions that make up the project's network.

Hence it has been argued that the current QRA model lacks sufficient detail to generate valid results in order to effectively support decision making. Currently, the model's output is occasionally used to set the right amount of contingency in project budgets and schedules. Next, it can be concluded that there is no use of three point estimates and risk correlations. The quantitative risk analysis is merely used as a tool to assess the total amount of risk, rather than that it is actively applied to support decision-making throughout the entire project lifecycle.

Finally, HMC's current approach lacks a number of critical elements to ensure that the process moves from planning towards effective action in practice. The project manager is the single person responsible for developing, implementing, and controlling risk implementation. Hence, the actual management of risks is still done implicitly, as there is no check to see if actions have been taken proactively. Risk review sessions focus on updating the project risk register and model, rather than explicitly discussing why risks have changed and which actions have been implemented. This makes it very difficult to review the effectiveness of the chosen approach and gather important lessons for better managing risks on future projects.

9.2 Recommendations

The recommendations are subdivided into recommendations for improving the effectiveness of the HMC PRM process to cope with risks in EPRD projects and recommendations on further research.

9.2.1 Recommendations for improving the HMC PRM process

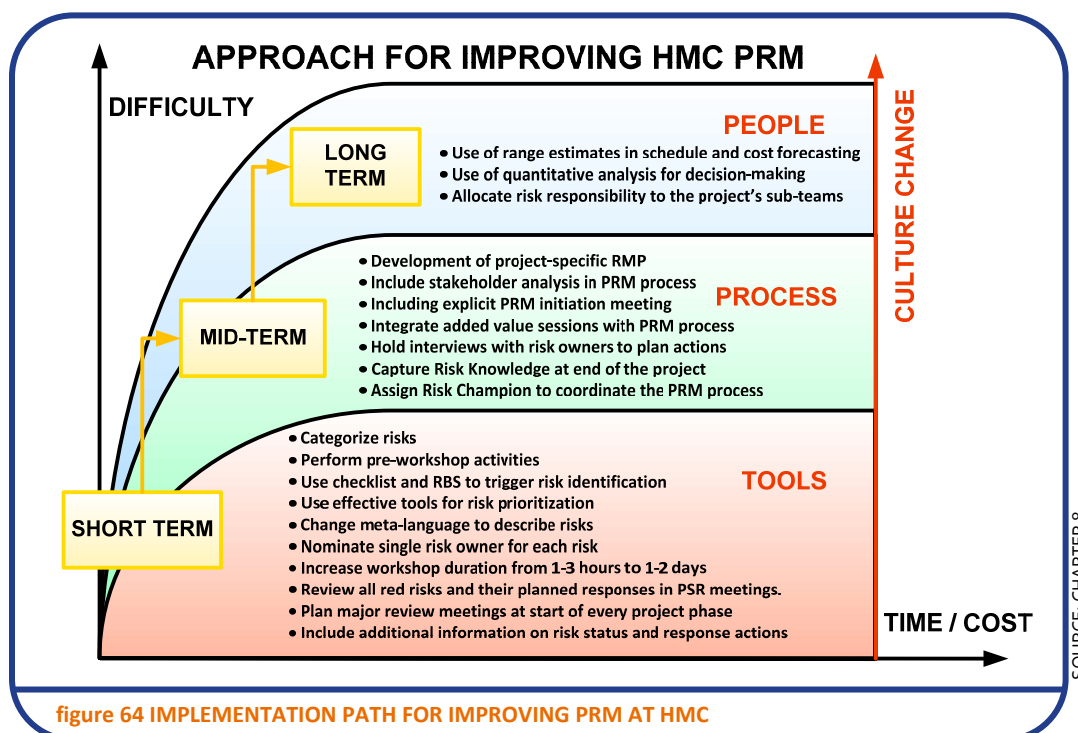
A number of quick wins are given to improve HMC's current risk management process to better cope with the risk profile of EPRD projects, focusing on the tools, techniques and steps that make up the PRM process. Next, a number of recommendations are given to improve the application of this process in practice. The theory, tools, techniques and training for risk management can only be effective if they are joined by the right communications, commitment and culture.

Recommendations for improving HMC risk management process to best practice standards

1. **Develop a project-specific Risk Management Plan (RMP):** PRM should be scalable, making it possible to vary the approach to fit the risk level of the project. Hence, it is recommended to include an explicit "initiation" step to determine the level of PRM implementation, documented in the project's RMP.
2. **Perform an explicit stakeholder analysis:** In EPRD projects, HMC is responsible for the risks of their subcontractors and interfaces. It is recommended to include subcontractors in the PRM process. This creates clarity, openness and transparency on all project risks and the management thereof.
3. **Change the Risk Workshop set-up:** It is recommended to increase the workshops duration from 1-3 hours to 1-2 days. Next, it is recommended to include a variety of identification techniques, specific tools for risk categorization and an explicit step that allocates each risk to a single risk owner.
4. **Use meta-language for describing risks that clearly separates cause, event and effect:** It is recommended to describe each risk in a three-part structure that clearly separates a risks definite cause, the uncertain event and the effect on project objectives. Correctly describing risks is critical for the development of effective responses.
5. **Change the use of tools and techniques in the Risk Workshop:** It is recommended to use a specific set of tools and techniques in each risk workshop, such as project-specific PI scales, a quantified risk matrix and risk factors for prioritization. Assumption analysis, checklists, SWOT analysis and a RBS structure can be used to stimulate out-of-the-box thinking and make the workshop more exciting.
6. **Perform Quantitative Analysis on the project-specific risk model:** It is recommended to use quantitative techniques to support decision-making. Quantitative analysis can be used to support risk response planning, estimate contingencies, compare alternatives, optimize resource allocation and show the effectiveness of planned responses and risk treatment actions.

7. **Plan, allocate and report explicitly on risk responses and risk treatment actions:** It is recommended to explicitly allocate the responsibility for the management of risks to those people in the organization that are best placed to do so. This ensures that the PRM process focuses on developing, assessing, implementing and reporting on specific risk responses and actions.
8. **Assign an internal project Risk Champion for communication, control and monitoring:** It is recommended to assign a risk champion to ensure that the actions and responses to risk are implemented with enough rigor and vigilance. A Risk Champion coordinates all PRM activities and reports directly to the project manager. The actual decisions, management and implementation of actions should however remain the responsibility of the designated risk owners.
9. **Extend requirement of regular risk updates:** It is recommended to include a regular review of the risk register into the PM system and to report changes to risks, so it becomes clear if risks have been expired, deleted, managed or occurred and to what reason. It is recommended to evaluate the risk register in PSR meetings, in order to check which actions have been developed and implemented.
10. **Plan and hold Major Risk Review Workshops at key points in the project lifecycle:** An EPRD project has several distinct phases during which the risk profile significantly changes. It is recommended to plan Major Risk Reviews at the beginning of each of these phases.
11. **Capture Risk Knowledge and Risk Lessons Learned during project close-out:** Finally, it is recommended to review the risk register, risk documents and the development of the project's risk profile at the end of each project. These documents contain relevant information on the risks that have actually occurred, as well as the effectiveness of risk response actions, which can be used to improve the management of risks on similar projects in the future.

It is recommended to use phased approach for the implementation of recommendations (see figure 64). On the short term, changes to current tools can quickly increase the effectiveness of the PRM process. Spending more time on identifying, assessing, and allocating risks in the risk workshop can significantly improve PRM in complex EPRD projects. Secondly, it has been argued to appoint an organizational risk sponsor that should further develop the suggested changes to the overall PRM process. Specific guidelines, templates and procedures need to be developed to scale PRM, create adequate controls and capture risk knowledge. It is recommended to first apply the new PRM procedure on a pilot project before it is rolled out over the entire company. Finally, there are some recommendations that require a change of organizational culture. Competent people, strong leadership and top management commitment are essential to ensure PRM effectiveness in practice.



SOURCE: CHAPTER 8

Critical success factors for effective implementation of project risk management in practice

From discussing the results and recommendations of the thesis project, it can be concluded that there is more to the management of risk than implementing effective processes, tools and techniques. For PRM to become effective, it should become a central part of the culture and practice of HMC, which is something far more difficult to achieve. Accordingly, one needs to address the human dimension that affects PRM in practice, making sure that there is risk mature culture, competent people and true commitment to the management of risks.

- **Risk “mature” culture:** A risk mature culture is neither averse to risk, nor is it seeking risks. This culture recognizes that risks are inevitable and that effective PRM is essential to the success of the company’s project and business strategy. As HMC has currently taken on a lot of “high risk” projects while at the same time cutting many of its resources for the explicit management of project risks, it might be classified as having a “risk-seeking” culture. Such a culture significantly affects the effectiveness of the PRM process in practice and the attitudes and behaviours of people to respond appropriately to risks.
- **Competent People:** Everybody within the organization should have the knowledge, skills and experience to recognize and manage risk at their level of responsibility. Hence for PRM to be effective, a shared understanding of the key concepts and principles of effective PRM is essential. Through continuous training one might develop a common language and acceptance of the benefits of proactively management risks, as well as improving people’s competence to do so effectively.
- **Top management Commitment:** For effective PRM, one requires strong leadership and a “*strong, influential and positive role model for adopting risk management practice*” (Murray Webster and Simon, 2007). PRM requires a strong commitment of HMC leadership and top management to use risk information in making appropriate decisions. Using risks and their management as a part of daily communications and ensuring that everyone is committed and honest about risk exposures and their uncertainty of achieving project objectives. Successful businesses and projects don’t react to change, but adopt a common attitude towards the proactive anticipation and management of change.

9.2.2 Recommendations for further research

- **Integration of risk management:** Risk management is often seen as a special project management feature, undertaken by experts using complicated tools and techniques. However for PRM to become effective, it should be integrated within the company’s culture and management systems. Hence, risk management should be seen as an integral part of project management and not as an optional or additional activity. More research is therefore needed to explore ways to integrate risk management into our common project management practices and processes. Furthermore, more research is required to explore the integration of various risk management tools and techniques. For instance, how one can effectively integrate qualitative and quantitative techniques in a single system.
- **Increased breadth and depth of risk management application:** Two dimensions for further research on risk management are the breadth and depth of risk management application. The current scope of risk management is limited and mostly concentrated on timescales and cost targets. However in some cases, there are strategic business objectives that are in conflict with the narrow focus of a single project. Hence, an expansion of the PRM process is needed to include programme risk management, business risk management, portfolio risk management, etc., so that risks are managed accordingly at all levels of the organization.
- **How to address behavioural aspects and risk attitude in risk management:** Risks are not managed by robots and many recognize that human psychology has a major influence on risk management. Hence, we should understand our attitude towards risks and the sources of bias that cause ineffective risk taking. There are many conscious, subconscious and affective factors that influence our attitude towards risks and how we interpret the results of the risk management process. Hence, the impact of behavioural factors on the PRM process should be studied in more detail, as well as developing the means to change our risk attitude when necessary.

Chapter 10

"In these volatile times, what you want from risk management is a little less risk and a lot more management"

The Chase
Manhattan Bank

10.1 Reflection on research approach

10.2 Reflection on thesis results

10.3 Reflection on research generalization

Thesis Reflections



This chapter reflects on the thesis approach and results from the perspective of the researcher. Next, the generalization of research's findings to other areas of application are discussed.

10.1 Reflection on research approach

On reflection, this thesis has been a journey of discovery with many struggles within its development over the past year. The motivation for the study has been the limited understanding of the effectiveness of current PRM practice in complex EPRD projects.

In the initial phase of the thesis there has been a lot of confusion due to the different "risk management processes" applied within HMC. Risk and the management thereof can be seen as a multi-dimensional concept which has a different meaning to different people. Especially within the Marine Contracting Industry, risk management is often associated with the safety risk analysis applied to all offshore operations. The difference between operational risk management, financial risk management and project risk management was not very clear on the outset of the thesis study, which caused a lot of miscommunications during the initial interviews. In the beginning of the project, a questionnaire had been developed and distributed among a broad sample of HMC's organization. However, some respondents assumed the questionnaire referred to the safety risk procedure, while others filled out the questionnaire with the PRM process in mind. Consequently, the results of the questionnaire were not considered valid as a basis for solid conclusions.

Next, there has been a lot of confusion on what is perceived to be a genuine risk. Risks are often entangled with the subject of uncertainty, problems or issues. The thesis has therefore explicitly discussed the different notions of risk and uncertainty from literature to provide a clear definition for both project risk and project risk management. However, throughout the entire thesis it has often been very difficult to gather information as the boundaries of what is perceived to be risk management (and what not) is not always clear.

On one hand, case study research can be seen as valuable approach to tackle the ill-structured nature of the research problem. Through the various interviews and discussions with project members from HMC, specific knowledge could be derived on the actual application and effectiveness of the current PRM process. But on the other hand, the research set out in this thesis can be criticised as it is for a great part based on subjective data from only a narrow segment of HMC's organization. Risk documents provide additional information to support the thesis findings. Because of the weakness of the chosen research approach in providing strong generalizations, many findings of the thesis have been supported by thorough research from similar studies to ensure that the thesis conclusions do not solely reflect the interpretation of the researcher.

10.2 Reflection on thesis results

There is no doubt that some of the conclusions described in this thesis report are confrontational and some might even consider the results to be very negative in comparison to the efforts HMC takes in managing the risks in their projects. However it should be noted that the researcher has taken great care in adequately supporting the various claims that are made within thesis report with the use of quantitative data, empirical results from other studies and literature on the subject of project risk management. The thesis findings and results are based on a structured approach that creates a rich perspective on the differences and similarities between the current best practice in PRM and the process applied in the project cases that have been examined. The validity of the thesis findings has been improved with the use of reflective interviews with key stakeholders of the PRM process and an interactive evaluation session with HMC's management team.

The results of the thesis are considered of great value to HMC in managing the risks in complex EPRD projects, giving a variety of practical solutions to improve PRM effectiveness. Apart from the specific tools and techniques and process elements that have been examined, the thesis has also discussed the "soft elements" that influence the implementation of PRM in practice. Accordingly, the results have been discussed in the light of HMC's risk attitude and culture, as well as the context of EPRD projects. Next, a step-wise implementation path has been designed that acknowledges the difficulty of changing the current PRM tools, process and culture. However, there has been no time left to test the effectiveness of proposed solutions and evaluate the thesis results within a practical situation. The thesis results should therefore be seen as a starting point for changing the way HMC manages its risks in complex project, creating a better understanding of the need for explicit PRM methods and a practical guideline to do so effectively. However, it is up to the management of HMC to decide which recommendations are actually implemented and rolled out over the entire organisation.

10.3 Reflection on research generalization

As discussed earlier, the results and research set out in this thesis are based on the review of two cases; hence there are only limited opportunities to generalize the thesis's conclusions. However the subject of improving project risk management in complex projects is widely recognized in a variety of industries in both the public and private sector. Empirical results from a study among 142 project managers indicate that PRM is the least applied PM practice across a large variety of industries, independent of the project's context, size or duration (Papke-Shields et al., 2009). Other studies in the construction industry (Kartam, 2001; Baker et al., 1999, Lyons and Skitmore, 2004), IT sector (Taylor, 2005; Loosemore, 2006), the Utilities sector (Van Wyk et al., 2008; Elkingston and Smallman, 2001) and the Transportation sector (Flyvberg, 2006) confirm these findings and clearly show the apparent gap between the theory and effective application of PRM in practice. Insights derived from this particular thesis can be used to further improve PRM tools and techniques and their use in a practical context. The thesis thereby shows which elements are currently the most lacking and provides a starting point for further exploring PRM practice.

However it should be noted that different industries may have a different attitude and culture towards risks which affects the perceived relevance of implementing PRM practices. Future research could examine these questions by using a larger sample of projects from a variety of industries. Next, this thesis provides little knowledge on how one can actually change the PRM process and culture within a specific organizational context to increase its effectiveness. The recommendations set out in the final chapters of the report can be seen as a promising approach to enhance the effective management of project risk within HMC; however, there is no evidence to support this claim. It is therefore desired to further explore the effects of the thesis recommendations across a large number of projects before make any generalizations to other industries.

References

A.

- Aken, J.E. (2004). Management research based on the paradigm of the design science: The question for field-tested and grounded technological rules. In: *Journal of Management Studies*, 41(2), 219-246
- Anaf, S., Drummond, C. and Sheppard, L.A. (2007). Combining case study research and systems theory as a heuristic model. In: *Qualitative Health Research*, 17(10), 1309-1315
- APM, (2004). *Project Risk Analysis & Management (PRAM) Guide*. 2nd edition, Association for Project Management Publishing, High Wycombe, UK
- Arrow, J. (2008). 'Knowledge-Based Proactive Project Risk Management', In: *AACCE International Transactions*

B.

- Baccarini, D. (1996). The concept of project complexity, In: *International Journal of Project Management*, 14(2), 201-204
- Bateman, T.S. and Snell, S. (2007). *Management: Leading and Collaborating in a Competitive World*. 7th edition, McGraw Hill, 16-18
- Beckham, J. (2008). *Contractors must adapt to changing priorities for platform removal*, International Marine Contractors Association
- Berstein, P. (1996). *Against the Gods, The remarkable history of risk*, John Wiley & Sons, New York, USA
- Bhoem, B.W. (1988). A spiral model of software development and enhancement. In: *TRW defense systems group*
- Boer, P. de, (2009). 'Offshore Decommissioning in the North Sea - A realistic Insight', Available at: HMC Intranet
- Bostock, J. (1999). 'Decommissioning of offshore installations', in: *ProQuest Information*, Available at: University of North Texas, USA
- Bourne, L. (2004). *The paradox of project control in matrix organizations*. Mosaic Project Services, Melbourne
- Bradbury, J. (2008). Consulting on Cost. In: *Offshore Engineer*
- Brkic, D. and Romani, D. (2009), *Unconventional contractual schemes for fast-track projects in the oil and gas industry*. PROTECH, New Delhi, India
- Brkic, D. (2009), 'Optimizing Risk by adopting new 'convertible contracts, Onshore Business and Technology Development', Available at: Snamprogetti
- Bruijn, J.A., ten Heuvelhof, E., in 't Veld, R.J. (1996), *Large-Scale projects: Decision-making and Management*. Samson Tjeenk Willink, Alphen aan den Rijn, NL, 29-33
- BSI, (2000). *PD 6668:2000: Managing Risk for Corporate Governance*, British Standards Institute, London, UK
- BSI, (2000). *BS 6079-3:2000: Project Management – Part 3: Guide to the Management of Business-related Project Risk*. British Standards Institute, London, UK
- Buttrick, R. (2005). *The Project Workout: A toolkit for reaping the rewards from all your business projects*, 3rd edition, FT Prentice Hall, Harlow, UK
- Byrd, R.C. and Velazquez, E. R. (2001). 'State of the Art of Removing Large Platforms Located in Deep Water', In: *Proceeding of the offshore technology conference 2001*

C.

- Capen, E.C. (1976). The Difficulty of Assessing Uncertainty, in: *Journal of Petroleum Technology*, 843-850
- Chapman, C. and Ward, S. (1997). *Project risk management: Processes, Techniques and Insights*. John Wiley and Sons, USA
- Chapman, C. and Ward, S. (2004). Why risk efficiency is a key aspect of best practice projects. In: *International Journal of Project Management*, 22, 619-632
- Chapman, C. (2006), Key points of contention in framing assumption for risk and uncertainty management. In: *International Journal of Project Management*, 24, 303-313
- Cleland, D.L. and King, W.R. (1983). 'Prescribing role in the matrix organization'. In: *System analysis and project management*, McGraw-Hill, New York, US, 349-368
- Cooke-Davies, T. (2005). Can we afford to Skimp on Risk Management?. In: *Project Manager Today*, 10 (9), 12-15
- Cooper, D., Gray, S., Raymond, G. and Walker, P. (2005). *Project Risk Management Guidelines – Managing risk in large projects and complex procurements.*, John Wiley & Sons, USA

- COSO, (2004). *Enterprise Risk Management – Integrated Framework*, Available at: Committee of Sponsoring Organizations of the Treadway Commission, USA
- Cox, L.A. (2008). What's wrong with Risk Matrices?, in: *Risk Analysis*, 28(2)
- Crawford, L. and Pollack, J. (2004). Hard and soft projects: a framework for analysis. In: *International Journal of Project Management*, 22, 645-653
- Crawford, L., Pollack, J. and England, D. (2006). Uncovering the trends in project management: journal emphases over the last 10 years. In: *International Journal of Project Management*, 24, 175-184
- CSA, (2002). *CAN/CSA-Q850-97: Risk Management: Guideline for Decision-makers*, Available at: Canadian Standards Association, Mississauga
- Cunningham, J. (2007). Crunch Time. In: *Professional Engineering*, 20(15), 20-21

D.

- Dake, K. (1991). Orienting dispositions in the perception of risk: An analysis of contemporary worldviews and cultural biases. In: *Journal of Cross-Cultural Psychology*, 22, 61-82
- Dinsmore, P.C. and Cabinis-Brewin, J. (2004), *AMA Handbook of Project Management*, Available at: American Management Association, New York, USA

E.

- Edwards, P.J. and Bowen, P.A. (2005). *Risk management in project organizations*. Available at: National Library of Australia, Sydney, 1-6.
- EIU, (2008). 'Poor risk management adds to credit crisis', Available at: Economist Intelligence Unit
- Elkington, P. and Smallman, C. (2000). Managing project risks: a case study from the utilities sector, In: *International Journal of Project Management*, 20, 49-57
- Enserink, B. and Thissen, W.A.M., Kamps, D.P., Bekebrede, G. (2004). *Analyse van complexe omgevingen*. Available at: TBM, Delft, NL

F.

- Flyvbjerg, B., Bruzelius, N. and Rothengatter, W. (2003). Megaprojects and Risk: An Anatomy of Ambition. In: *Cambridge University Press*, UK

G.

- Galorath, D. (2006). Risk Management Success Factors. In: *Project Management World Today*, 8(12)
- Gigh, J.P. van (1991). *System design, modeling and metamodelling*. Plenum Press, New York, USA
- GOPA-consultants, (1996). 'Selected European Technologies for the Decommissioning of Offshore Platforms and Other Offshore Facilities'. Available at: European Commission, Brussels, Belgium

H.

- Halinen, A. and Tornroos, J. (2003). Using case methods in the study of contemporary business networks. In: *Journal of Business Research*, 58, 1285-1297
- Hammond, J.S., Keeney, R.L. and Riaffa, H. (1998). The hidden traps in decision making. In: *Harvard Business Review*,
- Heerema, P. (2009). 'Message from Board of director HMC'. Available at: HMC intranet
- Hillson, D. (2001). Extending the risk process to manage opportunities. In: *International Journal of Project Management*, 20, 235-240
- Hillson, D. (2004). 'Risk Management: Best practice and future developments', Available at: Risk Doctor Limited
- Hillson, D. and Murray-Webster, R. (2007). *Understanding and Managing Risk Attitude*. 2nd edition, Gower publications, Aldershot, UK
- Hillson, D. and Murray-Webster, R. (2008). *Managing Group Risk Attitude*. 2nd edition, Gower Publications, Aldershot, UK
- Hillson, D. and Simon, P. (2007). *Practical project risk management – The ATOM Methodology*. Management Concepts, Virginia, USA
- Hullet, D.T., Hillson, D.A., Kohl, R. (2002). Defining Risk: A Debate. In: *Cutter IT Journal*, 1(2), 4-10
- Hubbard, D.W (2009). *The failure of Risk Management, Why it's broken*. John Wiley & Sons, New Jersey, USA

I.

- ICE, (2005). *Risk Analysis and Management for Projects (RAMP)*. 2nd edition, Available at: Institution of Civil Engineers, London, UK
- IEEE, (2001). *IEEE Standard 1540-2001: Standard for Software Life Cycle Processes – Risk Management*. Available at: Institute of Electrical and Electronic Engineers, New York, USA
- IEC, (2001). *CIE/IEC 62198:2001 International standards, Project Risk Management: Application Guidelines*. Available at: International Electro technical Commission, Geneva
- IRM/ALARM/AIRMIC, (2002). *A Risk Management Standard*. Available at: Institute of Risk Management/ National Forum for Risk Management in the Public Sector/ Association of Insurance and Risk Managers, London, UK
- ISO, (2009). *ISO 31000 Risk Management Principles and Guidelines on Application*. Available at: International Organization for Standardization
- Izundu, U. (2006), 'Woodmac: 42 billion will be needed for North Sea Decommissioning', Available at: Wood Mackenzie, London, UK

J.

- Jafari, A. (2001). Management of risk, uncertainties and opportunities on projects: time for a fundamental shift. In: *International Journal of Project Management*, 19, 89-101
- JSA, (2001). *JIS Q2001:2001(E): Guidelines for Development and Implementation of Risk Management System*. Available at: JSA Japanese Standards Association, Tokyo, Japan

K.

- Kerzner, H. (2003). *Project Management – A systems approach to planning, scheduling and controlling*. 8th edition, John Wiley and Sons, New Jersey, USA
- Kliem, R.L. and Ludin, I.S. (1997), *Reducing Project Risk*. Gower Publishing, Hampshire, UK
- Kutch, E. and Hall, M. (2005). Intervening conditions on the management of project risk: Dealing with uncertainty in information technology projects, In: *International Journal of Project Management*, 23, 591-599
- Kutch, E. and Hall, M. (2009). Deliberate ignorance in project risk management, In: *International Journal of Project Management*, doi:10.1016/j.ijproman.2009.05.003

L.

- Lakhal, S. Y., Khan, M.I., Rafiqul Islam, M. (2008). An "Olympic" framework for green decommissioning of an offshore oil platform. In: *Ocean & Coastal Management*: 1-11, doi:10.1016/j.ocecoaman.2008.10.007
- Lofstedt, R.E. and Ortwin, R. (1997). The Brent Spar controversy: An example of Risk Communication gone wrong, In: *Risk Analysis*, 17(2), 131-136
- Loosemore, M., Raftery, J., Reilly, C. and Higgon, D. (2006). *Risk Management in Projects*. 2nd edition, Taylor & Francis, New York, USA
- Lovaglio, D. and Kahneman, D. (2003). Delusions of Success: How Optimism Undermines Executives' Decisions, in: *Harvard Business Review*
- Luck, L., Jackson, D. and Usher, K. (2005). Case Study: a bridge across the paradigms. In: *Nursing Inquiry*, 13, 103-109

M.

- Masterman, M. (1970). 'The nature of paradigm'. In: *Criticism and the Growth of Knowledge*, Cambridge University Press, Cambridge, UK, 59-89.
- Mayo, K. (2009). 'Managing Decommissioning Risks for the Government', In: NPF North Sea Decommissioning Conference, Norway, DECC.
- Meredith, J.R. and Mantel, S.J. (2006). *Project Management – A Managerial Approach*. 6th edition, John Wiley and Sons, New Jersey, USA
- Mingers, J. and Brocklesby, J. (1997). Multimethodology: Towards a framework for mixing methodologies. In: *Omega international journal of management science*, 25(5), 489-509
- Mitchell, P.M and Planning, A. (1975), 'North Sea costs escalation study', Available at: Department of Energy, UK

- Morris, P.W.G. and Hough, G.H. (1987). 'The study of major projects'. In: Morris, P.W.G. and Hough, G.H., *The anatomy of major projects; a study of reliability of project management*. John Wiley & Sons, Chichester, UK, 3-20
- Mullaly, M. (2006). 'Longitudinal analysis of project management maturity', Presented at: PMI Research Conference, Montréal, Québec
- Murray-Webster, R. and Simon, P. (2007). *50 Lucid Thoughts: Shedding Light on Current Project Management Practice*. Lucidus Consulting Limited, UK

N.

- Nicholas, J.M. (2004). *Project Management for Business and Technology – principles and practice*. 2nd edition, BH Butterworth-Heinemann, Burlington, USA
- NOIA, (2006). 'History of offshore', Available at: National Oceans Industries Association
- Nolder, G. (2009), Improving Cost Estimation with Quantitative Risk Analysis, Be more precise by Employing Uncertainty. In: *VOCE Consulting*

O.

- O'Connor, P. E. C., Palmer, B.R., Byrd, S. (2004). 'Comparative assessment of decommissioning applications o typical North Sea and gulf of Mexico approaches to several categories of offshore platforms in the middle east', Presented at: International offshore and polar engineering conference, Toulon, France.
- OCG, (2007). *M_o_R: Management of Risk – Guidance for practitioners*. 2nd Edition, available at: Office of Government Commerce, London, UK
- Olssen, R. (2006). *Managing project uncertainty by using and Enhanced Risk Management Process*, Ph.D. thesis, Malardalen University Dissertations, Malardalen University Press, Vasteras.
- Olsson, R. (2007), In search of opportunity management: Is the risk management process enough?. In: *International Journal of Project Management*, 25, 745-752
- OSPMI (2007). *Project Risk Management Handbook (threats and opportunities)*. 2nd Edition, available at: Office of Statewide Project Management Improvement, Sacramento, SA

P.

- Papke-Shields, K.E., Beise, C., Quan, J. (2009). Do project managers practice what they preach, and does it matter to project success. In: *International Journal of Project Management*
- Perry, C. (1998). Processes of a case study methodology for postgraduate research in marketing. In: *European Journal of Marketing*, 32(9), 785-802
- Pender, S. (2001). Managing incomplete knowledge: Why risk management is not sufficient, In: *International Journal of Project Management* 2001, 19, 79-87
- Perminova, O., Gustafsson M., Wikström, K. (2008), Defining Uncertainty in projects – a new perspective, In: *International Journal of Project Management*, 26, 73-79
- PMI, (2004). *A Guide to the Project Management Body of Knowledge (PMBok)*, 3rd Edition, available at: Project Management Institute, Philadelphia USA
- Png, I. (2002). *Managerial Economics*, 2nd edition, Blackwell Publishing, 422
- Pollack, J. (2007). The changing paradigms of project management. In: *International Journal of Project Management*, 25, 266-274
- POST, (1995). Oil 'Rig' disposal, assessing environmental impacts. In: POST note 65, Available at: Parliamentary Office of Science and Technology, UK
- Pulsipher, A. (1996). *An international workshop on offshore lease abandonment and platform disposal: technology, regulation, and environmental effects*. Available at: U.S Department of Energy, New Orleans, USA
- Pulsipher, A. (2001). *Forecasting the number of offshore platforms on the Gulf of Mexico OCS to the year 2023*, available at: Coastal Marine Institute, Louisiana, USA

R.

- Raz T. and Michael, E. (1999). Use and benefits of tools for project risk management. In: *International Journal of Project Management*, 19, 9-17
- Raz, T., Shenhar, A.J. and Dvir, D. (2002). Risk Management, project success, and technological uncertainty, In: *R&D Management*, 32(2), 101-109

- Raz, T. and Hillson, D. (2005). A comparative review of Risk Management Standards. In: *Risk Management: An international Journal*, 7(4), 53-66
- Roth, M. (2009). 'RIMS press releases', Available at: Risk and Insurance Management Society, USA
- Romme, A.G.L. (2003). Making a difference: Organization as Design. In: *Organizational Science*, 14(5), 558-573
- RUSI Acquisition focus group, (2007). The Conspiracy of Optimism. In: *RUSI Defence Systems*, 60-65

S.

- Schaik, H.H.J. van (2006), *Risicomanagement binnen Dura Vermeer Railinfra b.v.: Building the Risk Diagnosing Methodology* (in Dutch), MSc. thesis, University of Twente, Enschede, NL
- SEI, (2002) *RSKM CMMI Risk Management Process*. Available at: Software Engineering Institute, AS
- Sheehan, E.D. (2007). 'Decommissioning Mega-Structures on the UK Continental Shelf', University College Cork
- Shenhar, A.J., Dvir, D., Levy, O. and Maltz, A.C. (2001). Project success: A Multidimensional Strategic Concept. In: *Long Range Planning Journal*, 34, 699-725
- Simon, P. (2003). The effective use of probability and Impact grids, Available at: Lucidus Consulting Limited, UK
- Simon, P. (2007), How to get total commitment to risk management from your project team. Presented at: 9th Project & Risk management conference, UK
- Sjolberg, B. (2009). Aker Draws line under frigg row. In: *Upstream online*
- Snijder, M. (2005). *The Bigger The Better? New approach to the offshore removal market*. MSc Thesis, Offshore Engineering, Technical University of Delft, Delft, NL
- Spuit, V.C.W. (2009). *Omgaan met risicomanagement; Een onderzoek naar de inbedding van integraal risicomanagement binnen Ballast Nedam Infra Projecten* (in Dutch), MSc. Thesis, Civil Engineering and Management, University of Twente, Enschede, NL
- Sol, H.G., (1982). *Simulation in information systems development*, Dissertation University of Groningen, NL
- Stake, R.E. (2000). *Case studies: In the Handbook of qualitative research*. Sage Publications, Thousand Oaks, CA
- Staveren, M. van (2009). *Risk, Innovation and Change: Design Propositions for Implementing Risk Management in Organizations*, PhD Thesis, University of Twente, Enschede, NL

T.

- Taleb, N.N. (2007). The Black Swan: The impact of the highly improbable. In: *Possibly Maybe*
- Taylor, H. (2005). Congruence between risk management theory and practice in Hong Kong vendor-driven IT projects. In: *International Journal of Project Management*, 23, 437-444
- Tellis, W. (1997). Introduction to case study. In: *The qualitative report*, 3(2)
- Trochim, W.M.K. (2006), 'Philosophy of research', Available at: Research methods knowledge base
- Turner, J.R. (1998). *The handbook of project-based management*, Mc Graw-Hill, 1-10

V.

- Veeneman, W.W. (2004). 'The strategic management of large technological projects', Available at: TBM, Delft
- Velazquez, E.R., Byrd, R.C. (2003). Gulf of Mexico Deepwater Platform Decommissioning. Presented at: Offshore Technology conference, Houston, Texas, USA
- Velzen, T. van (2007). Rijp voor de sloop, Heerema ontmantelt productieplatform North West Hutton. In: *De Ingenieur*, 49-55
- Verschuren, P. and Doorewaard, H. (1999), *Designing a Research Project*, Publisher LEMMA, Utrecht, NL
- Vrijling, J.K., van Gelder, P.H.A.J.M (2008), *Risk-based Marine Contracting*. PhD Research Project, Civil Engineering, Technical University of Delft, Delft, NL

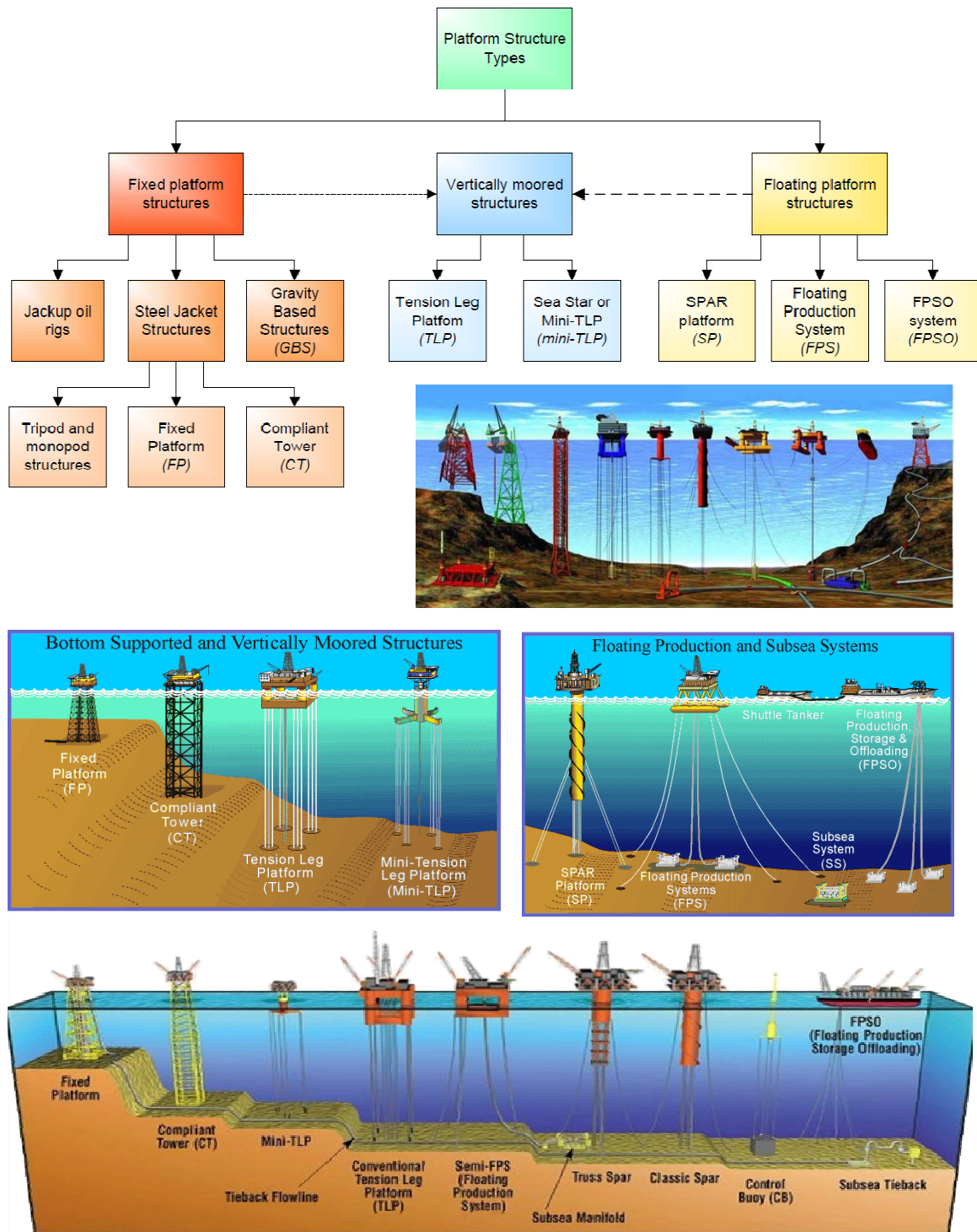
W.

- Walker, W.E., Harremoes, P., Rotmans, J., van der Sluijs, J.P., van Asselt, M.B.A., Jansen, P. and Krayen von Krauss, M.P. (2003). Defining Uncertainty: A conceptual Basis for Uncertainty Management in Model-Based Decision Support. In: *Integrated Assessment*, 4 (1), 5-17
- Ward, S.C. (1999). Assessing and managing important risk. In: *International Journal of Project Management*, 17(6), 331-336
- Williams, T.M. (1999). The need for new paradigms for complex projects. In: *International Journal of Project Management*, 17, 296-273

Y.

- Yin, R.K. (2003). *Case study research; Design and Methods*. 3rd edition, Sage Publications, Thousand Oaks, USA

Appendix A: Types of offshore platform structures



SOURCE : NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (2009)

figure 65 TYPES OF OFFSHORE PLATFORM STRUCTURES

JACK UP OIL RIGS

The Jack-up Platform consists of a triangular shaped (sometimes rectangular), box section barge fitted with three (sometimes four) moveable legs which enable the vessel to stand to the seabed in water depths of up to approximately 120 m.

The jack-up platform is able to float on the surface and withdraw its giant legs. Tug boats drag the rig to its location. There, it will lower its legs on the seabed, which all have a giant “spud” at their base. This large metal plate is designed to distribute the weight of the rig onto the seabed. Large water jets are used to clear the surface of the bottom in order to place the legs.

Electronically powered gear wheel systems allow the rig to lift itself above the sea level.

The rig acts as a kind of platform, but is mainly used for drilling purposes. The jack up oil rig is the most common mobile offshore drilling vessel, but can only work in shallow waters that are able to support its legs.



MONOPOD AND TRIPOD STRUCTURES

Monopod and tripod structures are small steel structure, used to support production facilities in shallow waters. They are situated in water depths of a few meters up to around 50m.

The monopod structure is less robust than larger multi-leg platforms making it vulnerable to impact from boats and working vessels.

Monopod structures hereby support in almost all cases unmanned facilities and are located away from shipping routes. Some monopod structures have a tripod base, on which the giant steel column rests. They require less steel, but are not able to withstand large forces.

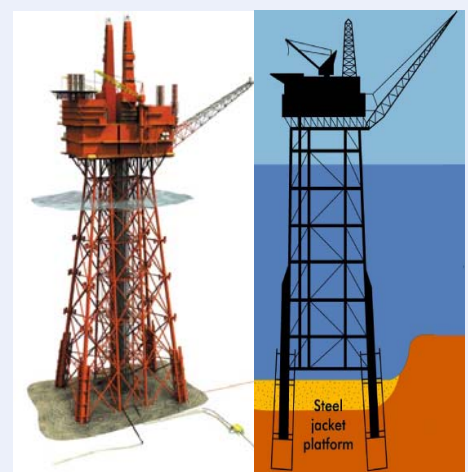


CONVENTIONAL FIXED PLATFORM (FP)

The conventional steel jacket platform is by far the most common kind of offshore structure. The jacket is made of steel pipes welded together in a tubular framework, often in complex intersections called nodes. These nodes require careful design, fabrication and inspection because they are very vulnerable to corrosion.

The structure is anchored to the seabed by giant steel pipes (diameter of 1-2 m). These structures are subject to fatigue loading as well as corrosion. It is vital that the jacket structure is designed appropriately for each operating location, water depth, conditions etc.

The largest concentration of fixed platform structures is located in the North Sea (30%). These structures are designed for shallow water developments, and stand in water depth from a few meters up to more than 400 meters.

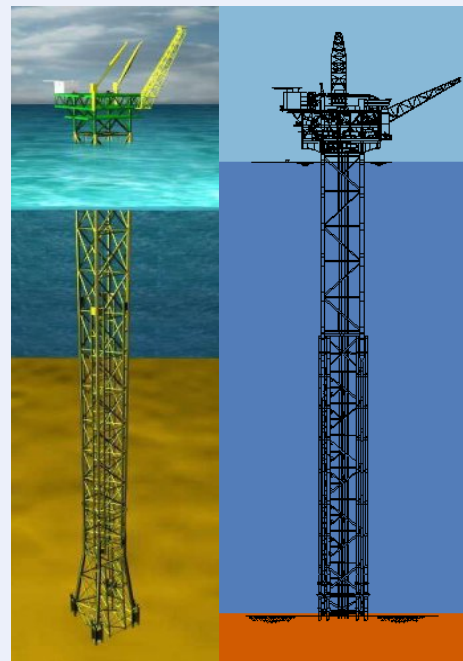


COMPLIANT TOWER (CT)

Similar to conventional fixed platforms, compliant towers have a steel tubular jacket that is used to support the topside facilities. But unlike normal jackets, compliant towers yield to the water and wind movements in a manner similar to floating structures. These towers are also secured to the seafloor with steel piles, but have far smaller dimensions than fixed platforms. Their design allows them to sustain significant lateral deflections and forces.

It was only until 1998 when the first compliant tower was installed at a water depth of 502m. The tower design has a base surface which is over 12 times smaller than a conventional jacket design, while they weigh almost half the amount of their counterparts. Because of these dimensions, the tower is able to move horizontally with the waves on a pace of 1,5-2% of their vertical length.

Currently, there are only a handful of these vertical steel tower structures worldwide. They are typically used in water depths ranging from 500-1000m.



GRAVITY BASED STRUCTURES (GBS)

Especially in the North Sea, you can find the massive concrete based platform structures. These platforms are generally larger than steel their steel competitors and sit on top of the seabed, stabilized by their own massive weight.

The base of these structures is made of reinforced concrete tubes, which are hollow on the inside. This makes it possible to float them in to their location and can later be used as storage compartments for crude oil. This highly reduces their offshore installation costs, and additionally they don't require any maintenance during operation.



SEA STAR (MINI TLP)

The Sea Star is a small version of the conventional TLP. It looks similar to a SPAR or Semi Submersible platform, but has three or four giant concrete legs attached on the bottom. These are moored to the ocean floor.

The Seastar or MOSES mini TLPs are relatively low costs, used in water depths between 200 en 1300m. They can be used as utility, satellite or early production platforms for larger deepwater discoveries.

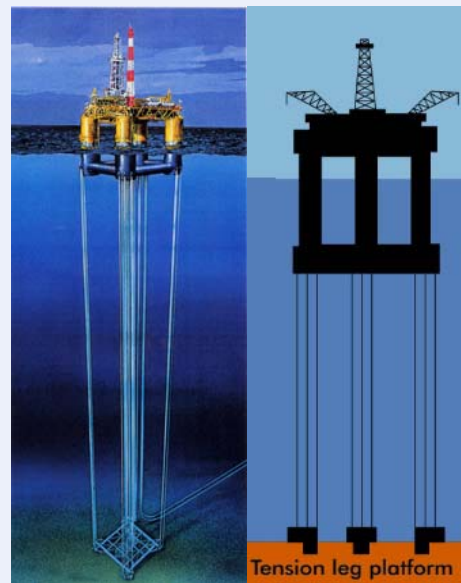


TENSION LEG PLATFORM (TLP)

A Tension Leg Platform (TLP) is a buoyant platform held in place by a vertical mooring system. The TLP's are similar to conventional fixed platforms except that the platform is maintained on location through the use of moorings held in tension by the buoyancy of the hull.

The mooring system is a set of tension legs or tendons attached to the platform and connected to a template or foundation on the seafloor. The template is held in place by piles driven into the seafloor. This method dampens the vertical motions of the platform, but allows for horizontal movements.

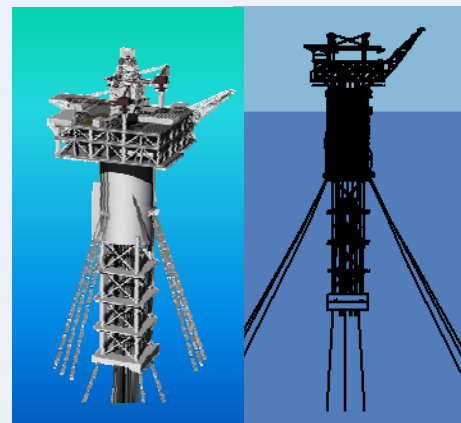
There are currently around 20 TLPs's in operation worldwide, used in water depths from 500 m up to 2200m. The first TLP's were installed in the 1980s, and have sufficient lower installation costs because they can be assembled onshore and then towed to their location.



SPAR PLATFORM (SP)

SPAR is a deep-draft floating caisson, which is a hollow cylindrical structure similar to a very large buoy. The SPAR relies on a traditional mooring system with anchors to maintain its positions. About 90% of the structure is underwater. Because of its distinguished shape, the spar produces very low motions and the protected center well provides an excellent configuration for deepwater operations and oil storage. It can be used in water depths of up to 3000 meters.

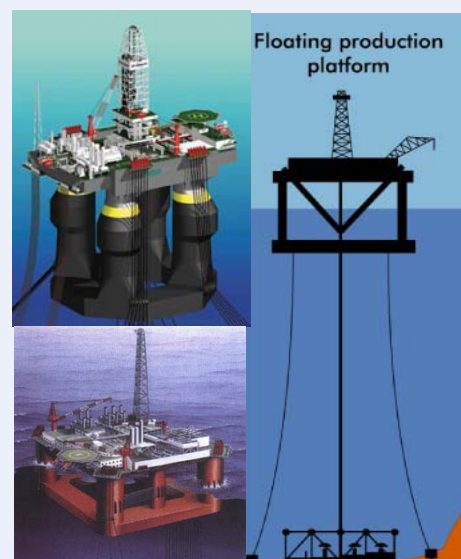
The diameter of a typical GOM spar is around 40m with an overall height of approximately 250m. Currently there are around 15 SPAR's worldwide with various types of design.



FLOATING PRODUCTION SYSTEM (FPS)

Floating production systems are moored to a location for extended periods and do not drill for oil or gas. They are mainly used for storage and production purposes. These facilities are moored to the ocean floor using conventional anchor systems.

Currently there are around 90 FPS's worldwide, used in water depths of in-between 1000 and 2000 meters.

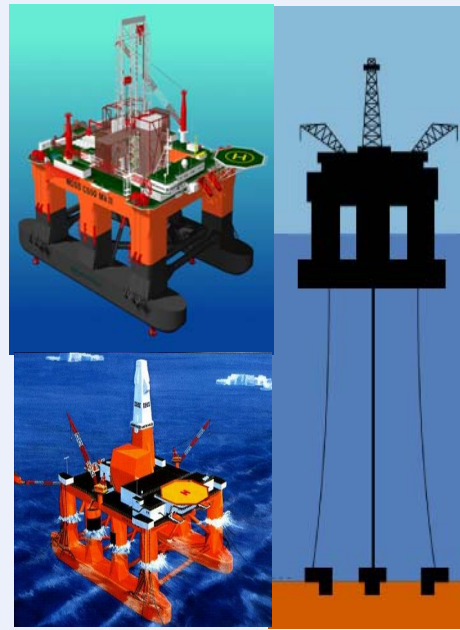


SEMI SUBERMISLE PRODUCTION VESSEL (SSPV)

Semi Submersible Production Vessels have twin hulls (columns and pontoons) of sufficient buoyancy to cause the structure to float, but of weight sufficient to keep the structure upright. Semi-submersible platforms can be moved from place to place; can be ballasted up or down by altering the amount of flooding in buoyancy tanks.

Generally they are anchored by combinations of chain, wire rope during drilling and/or production operations, though they can also be kept in place by the use of dynamic positioning. Semi-submersibles can be used in water depths from 60m up to 3050m.

Currently, there are around 40 SSPV's in operation used for production and drilling purposes.

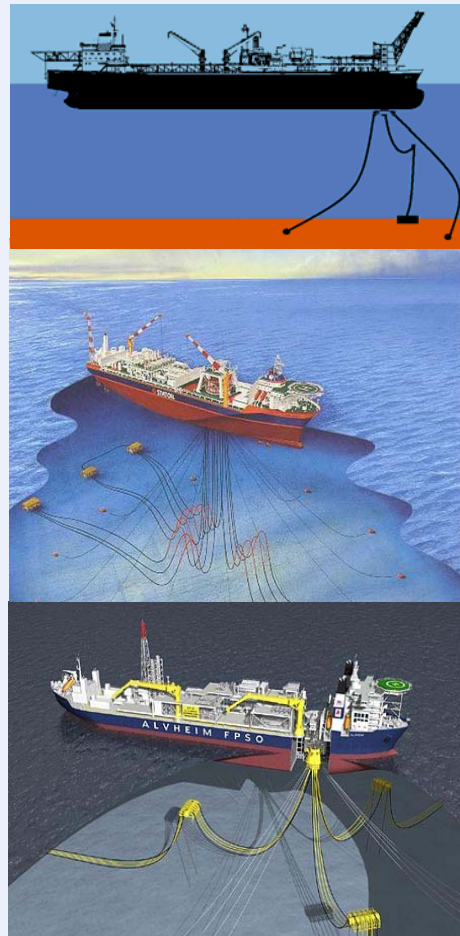


FLOATING PRODUCTION STORAGE AND OFFLOADING VESSEL (FPSO)

Floating Production Storage and Offloading vessels (FPSO) are increasingly being used for the production of oil from offshore fields. These systems allow operation of offshore field for which it is too expensive to make a pipeline infrastructure.

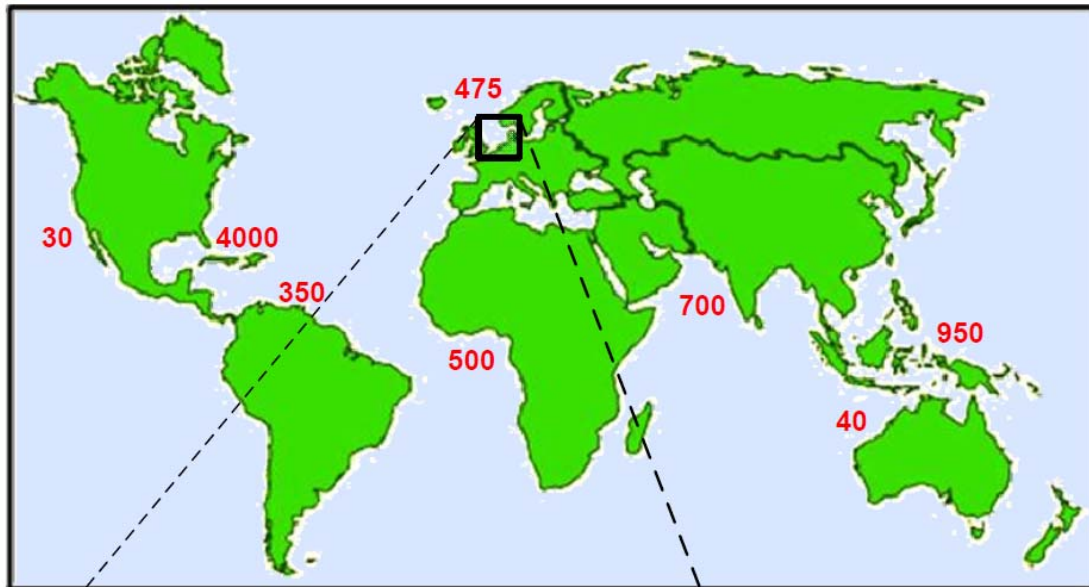
Currently, there are around 130 FPSO's worldwide. These can either be purpose-built or converted oil tankers. However, because an FPSO is permanently moored to a fixed location, it will experience year round weather conditions. Consequently, the hull of an FPSO has is subject to more severe fatigue.

FPSO are ideal for small, isolated and deep fields for which it is not economically possible to build a conventional fixed platform structure or pipeline. The big advantage of these systems is that they can simply lift their anchors and depart to a new production location when the field reaches a commercially unprofitable level.

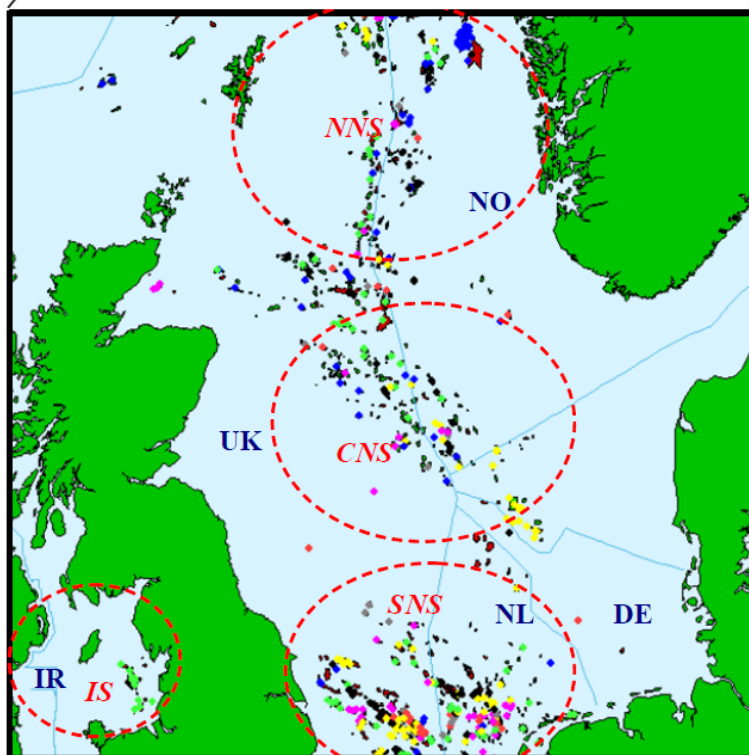


Appendix B: Overview world's offshore platforms

7000 offshore platforms worldwide



475 offshore platforms in North Sea



- No data available
 - 2001 - 2005
 - 2006 - 2010
 - 2011 - 2015
 - 2016 - 2020
 - > 2021
 - Removed
-
- NNS Northern North Sea
 - CNS Central North Sea
 - SNS Southern North Sea
 - IS Irish Sea
-
- NO Norway
 - UK United Kingdom
 - DK Denmark
 - DE Germany
 - NL Netherlands
 - IR Ireland

figure 66 OVERVIEW OF OFFSHORE PLATFORMS IN THE WORLD AND ON THE NORTH SEA

SOURCE : WWW.DECOMPLATFORM.COM

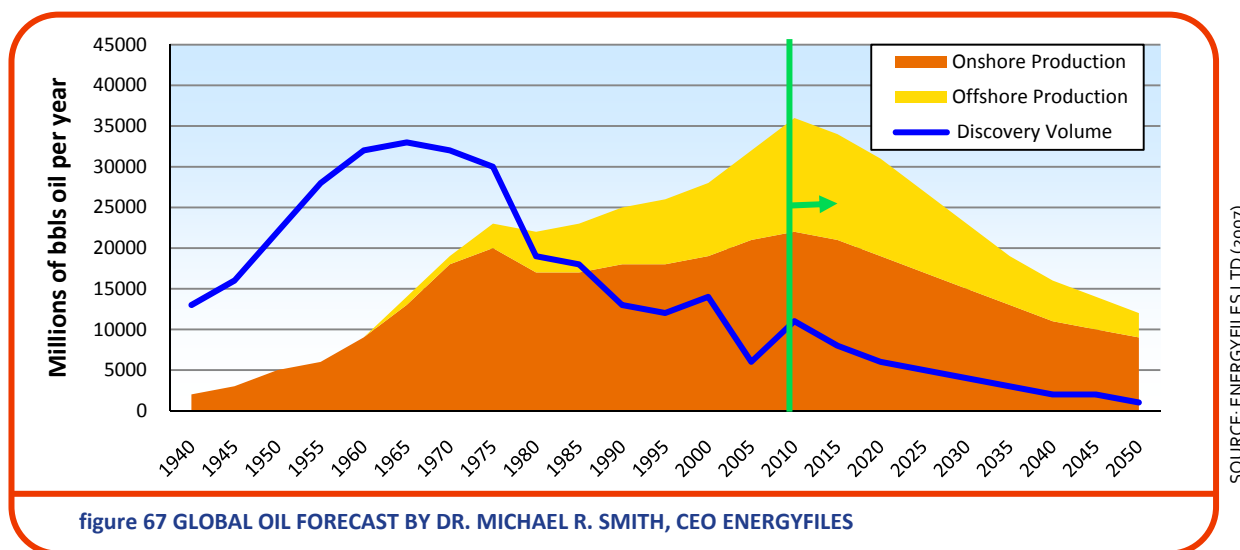
Appendix C: Worldwide offshore removal market

The availability of fossil fuels has played an important part in the shaping of today's society. Oil and gas have provided the energy supply for the industrial development in the 20th century, currently providing 63% of the world's energy needs. Starting with the first discovery of oil in 1859 (Pennsylvania, USA), the worldwide search for oil has rapidly expanded and ultimately faced the challenge of moving "offshore".

C1. The offshore oil market

Offshore oil production took off in 1947, when the Kerr-Mc Gen Company installed the first oil producing platform in the GOM. Peaking discoveries of oil & gas in the 1960s and 1970s moved the industry to the North Sea, where construction took place into much harsher and deeper waters (NOIA, 2006). Incredible technical challenges were overcome, resulting in some of the most complex facilities ever constructed by mankind.

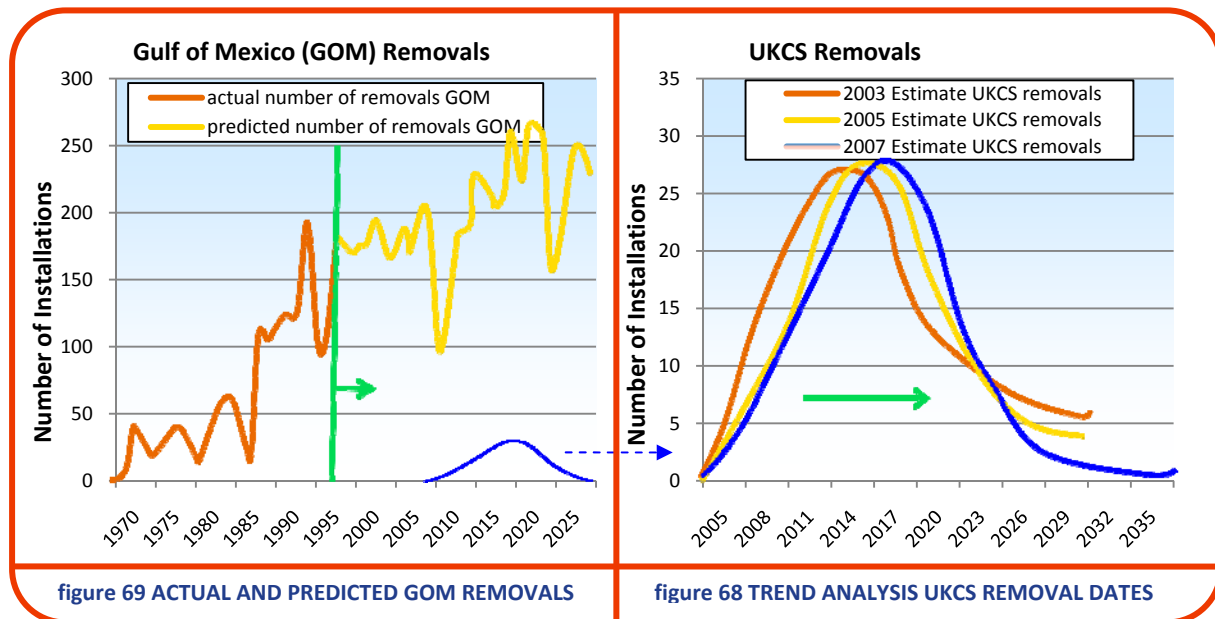
Consequently, about one third of the current world's oil production comes from offshore facilities, and this share is expected to keep on climbing with the prospect of continuing deepwater explorations (see figure 67). Most of these offshore facilities are 'fixed' (supported by large steel jackets resting on the seabed), but floating platforms are rapidly gaining importance world-wide. Because every platform is purpose build, there exist many different types of offshore installations, depending on the water depth, material used, type of design, location etc.



C2. Offshore decommissioning and removal market estimation – Focus on North Sea

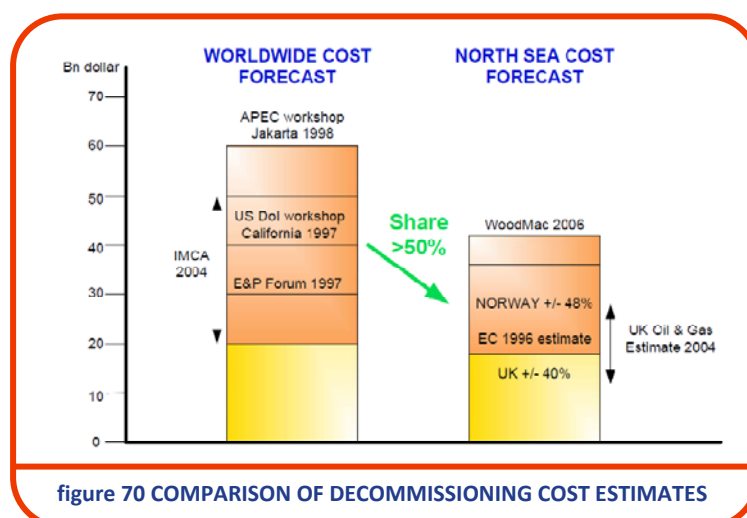
Today, about 7500 offshore platforms exist worldwide, located on the continental shelves of 53 countries (GOPA-consultants 1996). About 4,000 of these are situated in the Gulf of Mexico, 950 in Asia, 750 in the Middle East, 650 in Africa and almost 500 platforms in the North Sea. Eventually, all of these platforms will have to be decommissioned and removed.

Most of current decommissioning knowhow comes from projects executed in the Gulf of Mexico (see figure 69), where approximately 2,000 small structures have already been removed (Pulsipher 2001; O'Connor 2004; Lakhal 2008). However, these are light weight structures (<5,000 tons) compared to the North Sea platforms that have to withstand constant heavy weather in much deeper waters. Therefore the industry is in no doubt that the biggest challenges are yet to come as they imagine the complexity and difficulties of removing the larger structures located in the North Sea. A total of 40 platforms have been removed in this area, indicating the lacking of experience compared to the GOM (O'Connor 2004). But as market forecasts indicate a rapid growth in demand for North Sea platform removals in the next 10 years (see figure 68), attention has shifted to the waters of the North Sea.

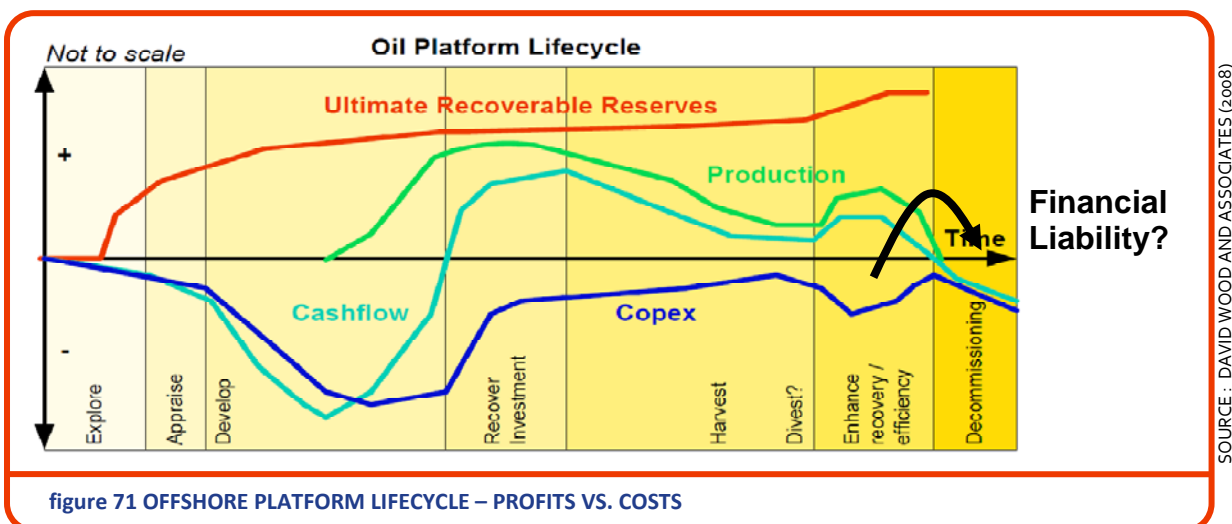


The focus on North Sea removals is further emphasized by estimations of the worldwide decommissioning cost. While only 5% of the all platforms is located in the North Sea, they will cover over half of the worldwide cost for their removal, estimated at in between 30 to 60 billion USD. Shown in figure 70, the European Commission estimates that in the EU alone, 20 to 40 billion USD will be spent on decommissioning over the next 25 years, of which approximately 88% for the removal of the heavier fixed structures located in the UK and Norway (GOPA-consultants 1996). More recent calculations of the UK DECC indicate a cost increase of £15 billion to £22 billion between 2006 and 2008 for the decommissioning of the UKCS platforms. But as the financial crisis manifests, these costs seem to be declining again and are at the moment estimated at a total of £20 billion for the UK (Mayo 2009).

The eventual cost for the decommissioning and removal of a platform are difficult to forecast when platforms are installed. In theory, if these costs would be known on beforehand one might have a better understanding of the most cost effective platform choice for a particular oil field. However, this is not the case. Costs of an oil production platform are difficult to calculate due to unpredictable accidents, mechanical failures, market conditions, political inventions and of course the oil price. Because of these problems, project planners have given more attention to allocating costs to production rather than the more uncertain phase of removing such a platform. Operational phases such as exploration, development and production are well reported and studied, but there has been little emphasis on the final phase of a platform's lifecycle.



For a large structure in the North Sea the total decommissioning cost is estimated in between 100 and 200 million dollars. This is a very high burden for the operating oil company, hence most decommissioning project are being postponed as much as possible. Near the end of the lifecycle of an offshore platform, production gradually declines and with it the revenue cash flow. This implies that companies will have to start making reserves for the platform's removal many years before the actual COP, to make sure they are able to pay the final burden (see figure 71)



SOURCE: DAVID WOOD AND ASSOCIATES (2008)

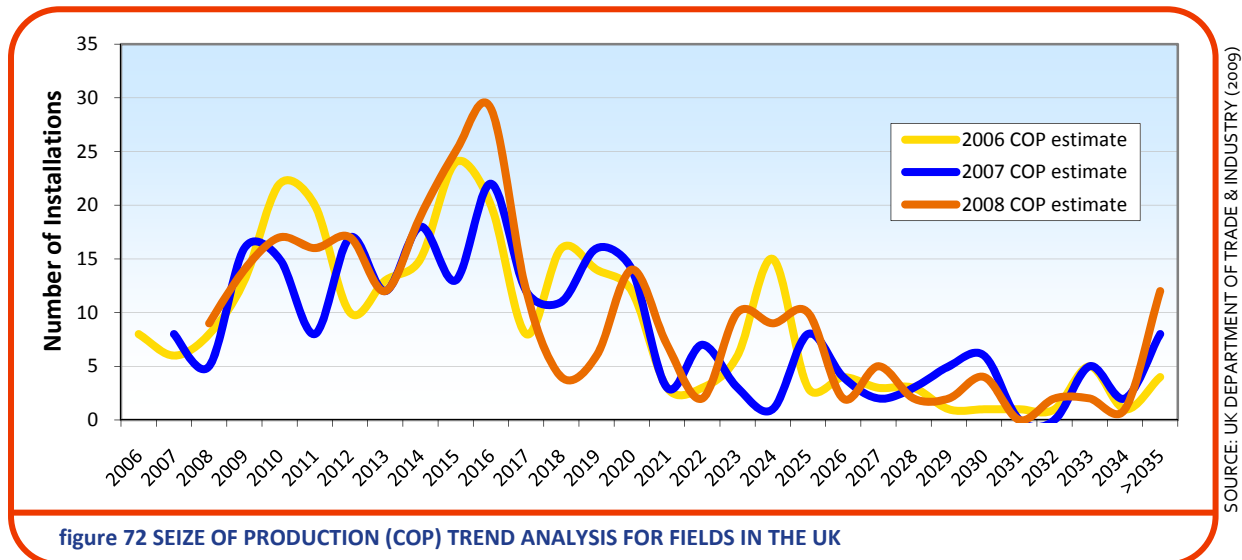
The financial liability for decommissioning is handled for some years by decommissioning security agreements (DSAs) to ensure an asset owner has sufficient funds to meet its legislative obligations. Most licensees meet the obligations in the DSA by obtaining credit from banks, which may require considerable sums as a surety. Around 80 million dollars is not unusual for such a warranty. For smaller companies, decommissioning heavily challenges their cash resources which may hold a strong impact on their ability to invest in an offshore oil field. Each state has a different fiscal treatment of the cost for offshore decommissioning, to make sure companies are able to pay for their platform removals. Generally, approaches might be divided into royalty/tax type regimes and production sharing regimes (Mostly in Asia and Africa).

In the UK, the costs can be carried back against three to five years of previous taxable income. In most situations this will give some relief on behalf of the oil company. All companies in the UK that pay the Petroleum Revenue Tax (PRT) could claim the refund of those taxes to be carried back. The advantage of the system is that it directly relates back to the tax paying ability of a field. The other approach does not use a tax payback system, but gives a tax credit on a percentage of the decommissioning cost. This system is used in Norway, where licenses are granted by the government in which an agreed part of the removal costs are paid to the state. In this way the government ensures that part of their tax collected for the production is saved as an insurance to pay for the final removal costs.

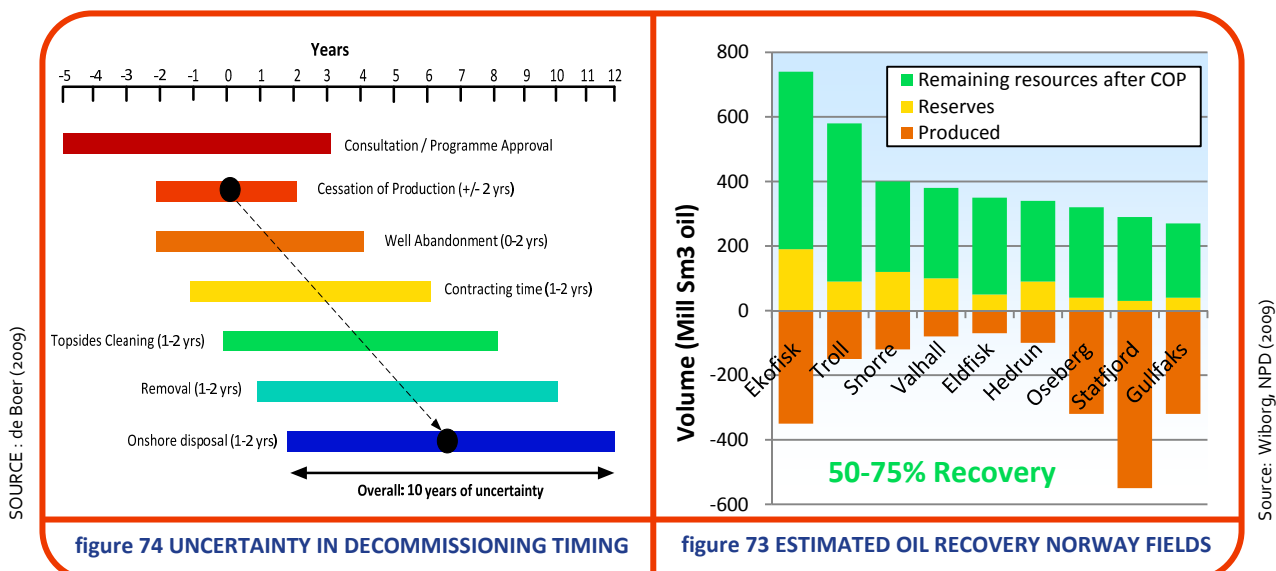
C3. Dynamics of offshore removal market

Forecasting the actual timing of decommissioning projects is inherently difficult for each platform structure (see figure 74). The profitability of an offshore platform is directly influenced by the oil price. When the oil price kept on rising between 2002 and 2008, the economic lifetime of many oil producing fields grew as well, partially explaining the forward trend in estimated removal dates shown in figure 68. Oil companies are performing a lot of research on improving production and reservoir recovery methods. One example is the use of CO₂ gas to enhance field recoveries. This allows companies to continuously postpone the economic cut-off of their producing fields (Beckham 2008). The changes in estimated COP dates shown in figure 72 give a clear indication of the constant dynamics within the removal market. In the year 2008 alone 39 fields in the UK changed their

estimated COP date by more than 5 years. In total, 25 fields extended their platforms production life, while 14 fields announced an early retreat (Mayo 2009). In spite of many efforts the enhancement of platforms recoveries, it is expected that more than half of the oil will remain in the ground. One of the world's largest oil producers, Saudi Aramco expects a maximum recovery of 50-75% from the largest offshore fields in Norway (see figure 73). One may ask itself if platform decommissioning activities are planned to early or that efforts for their redevelopment are too late. During the past years, new plans have been developed for reusing offshore platforms and fields for other purposes, like gas storage or carbon sequestration. Another option is to divest large offshore platforms to tail-end producers that continue production operations in order to get the lasts drops out of the field.



One may conclude that the petroleum industry is actively searching for ways to delay decommissioning and extend the productive life of their assets, trying to recover the remaining hydrocarbon resources to the maximum. This fact, together with many other timescale uncertainties (see figure 74) makes it very difficult for HMC to make solid assumption for the future. HMC therefore questions if the required investments in equipment and technology for offshore decommissioning will eventually pay off. When there is a peak in removal activity, followed by a period where no removals take place, new experience and knowledge may get lost as the cost of keeping a stable and skilled work force is very high (Boer 2009). HMC's challenge therefore is not only to learn quickly from the first removal projects, but also to ensure that this knowledge is retained in the highly volatile decommissioning market.



Appendix D: Legal framework & regulations

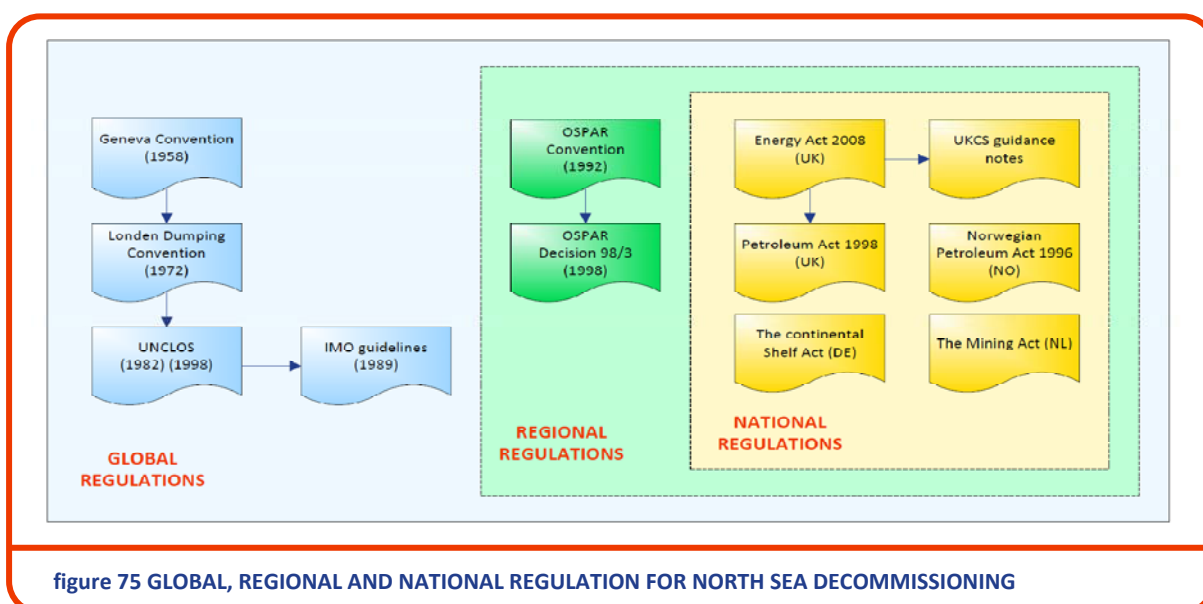


figure 75 GLOBAL, REGIONAL AND NATIONAL REGULATION FOR NORTH SEA DECOMMISSIONING

The assessment, planning, comparing, approval and execution of decommissioning activities are regulated through a complex framework of different treaties, conventions and laws. These can be divided into global, regional and national regulations. To determine to which regulations the decommissioning process should apply, one must first consider any relevant international treaties which in their turn give implications for regional and national law on decommissioning (see figure 75). The regulations and conventions that form the legal framework for offshore decommissioning activities in the North Sea will be discussed in this appendix.

D.1 Global Regulations

There are a number of universal guidelines and treaties of potential relevance for offshore decommissioning. The first convention that addressed abandonment and removal of offshore facilities was the Geneva Convention of 1958. The more refined standard was stated in the 1972 United Nations Convention on the Law of the Sea (UNCLOS), following from the London Dumping Convention (LC) of 1972. However the specific standards are stated in the International Maritime Organization (IMO) Guidelines of 1989.

D.1.1 Geneva Convention 1958

The Geneva Convention set the legal framework to allow industry to explore and exploit the continental shelves. It was signed globally when the first offshore facilities were installed, stating very clearly that:

- *"Any installation which is abandoned or disused must be entirely removed"*

In these days there were only a few installations in shallow water such as in the Gulf of Mexico. At that time, the complete removal of such installations was not seen as technically or economically difficult. Many platforms in these waters have been removed completely without any problems. However, as offshore development in the 1960s and 1970s into the deeper water and more hostile environments, it became apparent that the entire removal of platforms would be unreasonably. The huge deepwater platforms would be very dangerous, costly and in some cases impossible to remove. The requirement of total removal for all installations also raised the question of the long-lasting effects on the environment. This eventually resulted in the 1972 London Dumping Convention (LC) to protect the marine environment from hazards of dumping at sea.

D.1.2 London Dumping Convention 1972

Recommended by the United Nations, the convention came into force in 1975, calling a halt to unregulated dumping at sea. The convention applies to all marine waters world-wide other than internal waters of the states. Dumping is defined in Article III (i)(a) as:

- *“Any deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms or other man-made structure at sea”*

However, Article III (ii)(b) provides that dumping does not include:

- *“Placement of matter for a purpose other than the disposal thereof, provided that such placement is not contrary to the aims of this convention”*

It is through this article that leaving platforms on the seabed as artificial reefs is not considered as dumping and hereby allowed. Eventually, this led to the “Rigs to Reef” program in the Gulf of Mexico, where steel jackets are toppled and converted into diving sites and fishing spots. The next international treaty recognized that the simple rule of completely removing all installations was not applicable in all situations. In the case of the larger installations a more versatile approach might be necessary. This resulted in the 1982 United Nations Convention on the Law of the Sea (UNCLOS).

D.1.3 United Nations Convention on the Law of the Sea 1982

The UNCLOS came into force in 1994, stating a more refined standard on offshore decommissioning, saying that:

- *“Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by competent international organizations. Such removal shall also have due regard to fishing, the protection of the Marine environment and the rights and duties of other States. Appropriate publicity shall be given to the depth, position and dimensions of any installations or structures not entirely removed”*

Although the first sentence sets a clear standard of removing installations, it is clear that the second sentence implies that not all installations will have to be removed entirely. The UNCLOS supersedes the 1958 Convention and sets a new general standard regarding decommissioning, but did not specify which organization should set the appropriate guidelines. Currently, the generally recognized standards are those described by the International Maritime Organization (IMO).

D.1.4 IMO guidelines for the removal of offshore installations and structures 1989

These guidelines state that all disused installations and structures in the Exclusive Economic Zone and on the Continental Shelf should be entirely removed, except where non-removal or partial removal would be consistent with the guidelines. At the time of adoption, there were 450 installations identified worldwide of which 7% might be considered for less than total removal. This means that it is possible to apply derogation from the general rule if it would be appropriate. The guidelines state that:

- *“All installations need to be totally removed if they stand in less than 75 meters of water and weigh less than 4.000 tons in air” (became less than 100 meters of water in 1998)*
- *“All installations installed after 1 January 1998 in less than 100 meters of water and weighing less than 4.000 tons will be completely removed” (changed into all structures after 1998)*
- *“All abandoned or disused structures located in approaches to, or in straits used for, international navigation or routes used in sea-lanes shall be entirely removed”*

Exceptions on the general rule may be permitted if:

- *“Total removal is not technically feasible; or”*
- *“Total removal would involve an extreme cost or extreme risk to personnel or the environment”*

These guidelines allow an individual state to put its own detailed legal regime for decommissioning in place. The difference between the London Dumping Convention is that the IMO Guidelines cover only the removal of structures from a navigational safety perspective. The authority for disposal at sea is stated in the LDC.

D.2 Regional Regulations

Resulting from the UN Regional Seas Program of the early 1970s, there are currently fifteen regional conventions worldwide controlling the pollution of the marine environment. The relevant convention protecting the marine environment of the North Sea and the North-East Atlantic is the Oslo and Paris Convention (OSPAR).

D.2.1 OPSAR; Oslo and Paris Convention 1998

The Convention for the Protection of the Marine Environment of the North-East Atlantic (applying to the entire North Sea and UK Continental Shelf) came into force in 1998. OSPAR is in fact a combination of the 1972 *Oslo Convention for the Prevention of Marine Dumping from Ships and Aircraft* and the 1974 *Paris Convention on Prevention of Marine Pollution from Land-based Sources*.

OSPAR participants are Belgium, Denmark, the ECC, France, Germany, Iceland, Ireland, Netherlands, Norway, Portugal, Spain and the UK. Interesting is that this list contains countries with radically different political attitudes toward environmental issues. The UK, with a large offshore industry, has always tried to implement a pragmatic and economically motivated policy regarding offshore decommissioning. Germany, with no offshore industry, has always desired a more environmentally robust desire to forbid all dumping at sea.

In addition to the UNCLOS convention, the OSPAR convention sets clear obligations on the Contracting Parties of decommissioning projects and specifies the requirements and procedures for the removal of offshore installations. The convention clearly states that all actions shall be licensed and decided on a case-by-case basis. The general approach typically involves a review and comparative analysis of technical feasibility, health and safety, environmental impact, public acceptability and cost for each of the decommissioning options. It states that:

- *“Reuse, recycling or final disposal on land will generally be the preferred option for the decommissioning of offshore installation in the maritime area”*
- *“National legal and administrative systems of the relevant Contracting Parties need to make adequate provision for establishing and satisfying legal liabilities in respect of disused installations”*

In essence, the convention does not prohibit the disposal of platform remains at sea. Permits for derogation must specify the terms and conditions of derogation, including specifying necessary monitoring of the parts left at sea, details of the owner, and specifying the person liable for meeting claims for future damage caused by those parts. Furthermore, the permit should provide a framework for assessing and ensuring compliance, including the issue of a report following completion of the disposal-at-sea operations describing how these were carried out.

However, as a result of the OSPAR Decision 98/3 reached at the Ministerial Meeting of the Contracting Parties in July 1998, the case-by-case consideration of derogations was brought to an end by clearly specifying the rules for disposal and derogation. The Decision 98/3 hereby aimed at reducing the number of cases for which derogations to the general ban on sea disposal may be considered.

D.2.2 OPSAR Decision 98/3

The OSPAR decision that came into force on the 9th of February 1999 stated the future norm of re-use, recycling or disposal on land for all installations. After the analysis technological and economical issues, it seemed that all topsides and most of the large steel structures could be removed and recycled on land. This led to the conclusions that toppling of structures in the North Sea was no longer allowed and every jacket structure weighing less than 10.000 tons needs to be removed completely. The key point of the decision stated that:

- *“All dumping of platforms at sites remote from E&P activities is banned (9 February 1999)”*
- *“All toppling of platforms in-situ is banned”*
- *“Large steel structures weighing less than 10.000 tons need to be removed completely”*
- *“For large steel structures, only the footings may be left in place.”*
- *“In the future, all new steel structures need to be removed completely”*
- *“Consideration of derogations are permitted in case of*
 - *steel installations weighing more than ten thousand tones in air;*
 - *gravity based concrete installations;*
 - *floating concrete installations;*
 - *any concrete anchor-base which result, or is likely to result, in interference with other legitimate uses of the sea”*

The decision also states that any decision on derogation is only allowed if Contracting Parties:

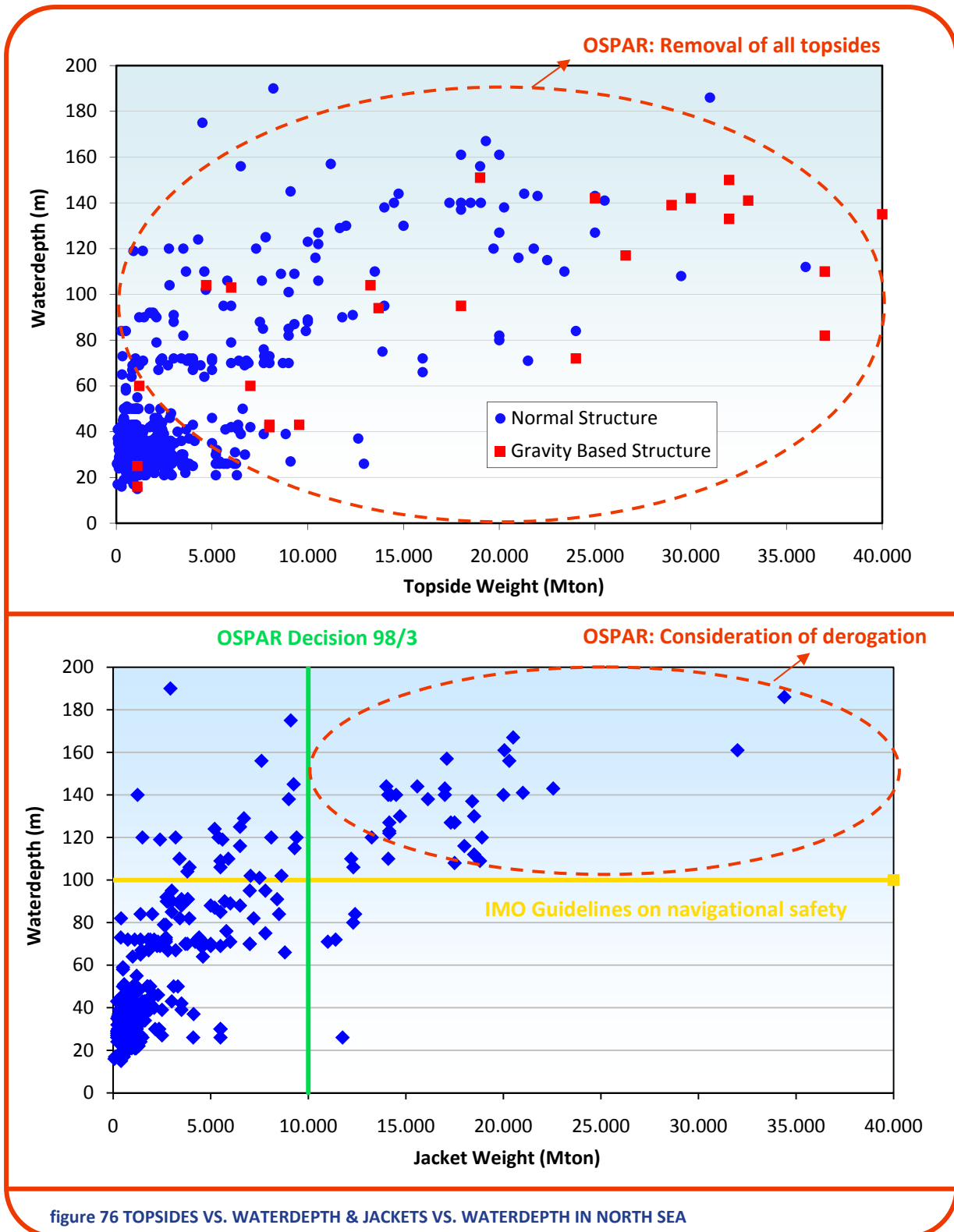
- *“Carried out a detailed comparative assessment of position, including consideration of the practicality of alternative solutions, such as reuse, recycling and final disposal at land, and*
- *Consulted with the other Contracting Parties and taken their views into account, which could involve the holding of a special consultative meeting to address opposing views.”*

The decision hereby clearly specifies the framework for the assessment of proposals for the disposal at sea and on which ground derogations may be possible. The requirements, consultation procedure and permit conditions are also stated in the OSPAR convention, regulating the process of decommissioning program approvals. Generally, all topsides must be returned to shore for re-use or recycling and the following framework can be used for the supporting structures (see Table 20):

Table 20 Framework for showing possible options for removing platforms on the North Sea

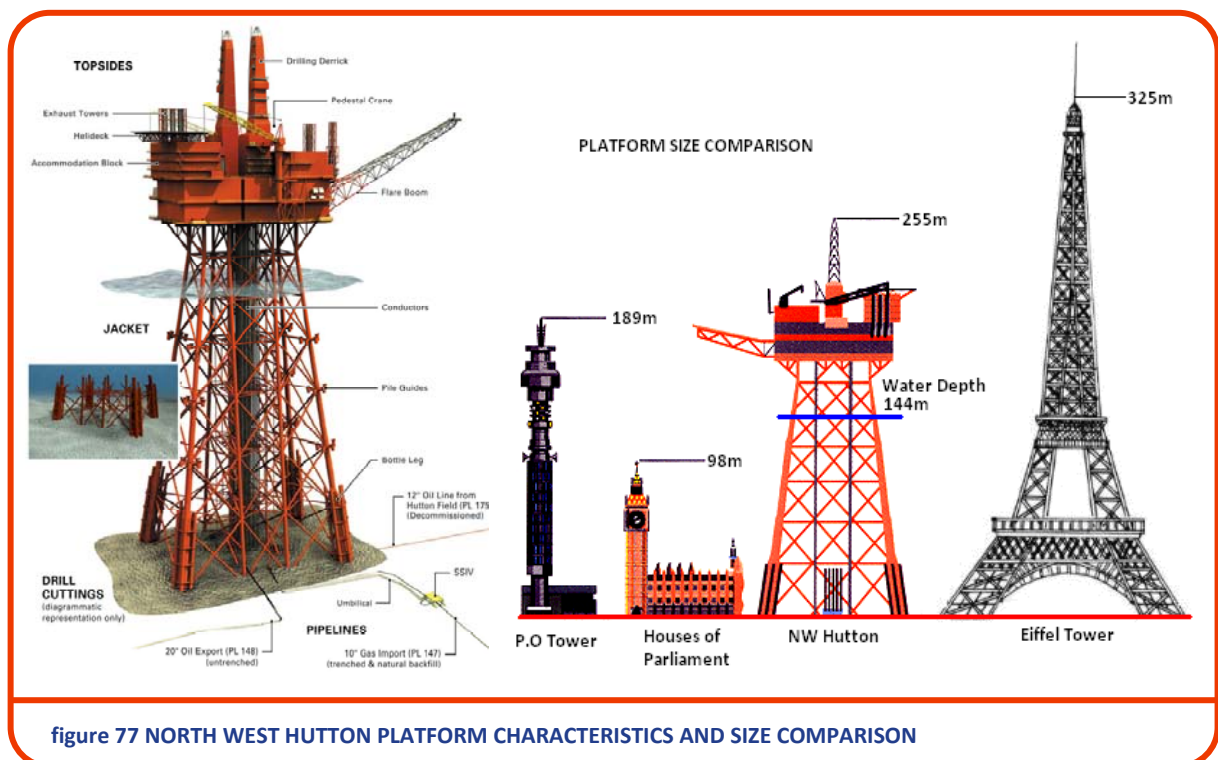
TYPE	WEIGHT (tons)	REMOVAL TO LAND		LEAVE IN PLACE	RE-USE	DISPOSAL AT SEA
		COMPLETE	PARTIAL			
Fixed steel	< 10.000	Yes	No	No	Yes	No
Fixed steel	> 10.000	Yes	Yes	No	Yes	No
Concrete GBS	Any	Yes	Yes	Yes	Yes	Yes
Floating	Any	Yes	No	No	Yes	No
Subsea	any	Yes	No	No	Yes	No

Currently, there are 500 installations in the North Sea, of which over two-thirds are in shallow waters (<100m water depth) and must be removed under the UNCLOS guidelines for navigational safety. The OSPAR debate specifically focuses on the large deepwater structures, most of which lie in the UK and Norwegian waters. In practical terms, the complete removal option has been surrendered for 70 large steel installations under the International IMO Guidelines. Of this group, 41 platforms fall into the OSPAR category of “large steel installation” (>10,000 tons jacket weight) and can be considered on a case-by-case basis. Additionally, there are 34 concrete structures that may remain in place.



SOURCE : SNIJDER (2005)

Appendix E: Fixed platform Characteristics



SOURCE : BP (2006)

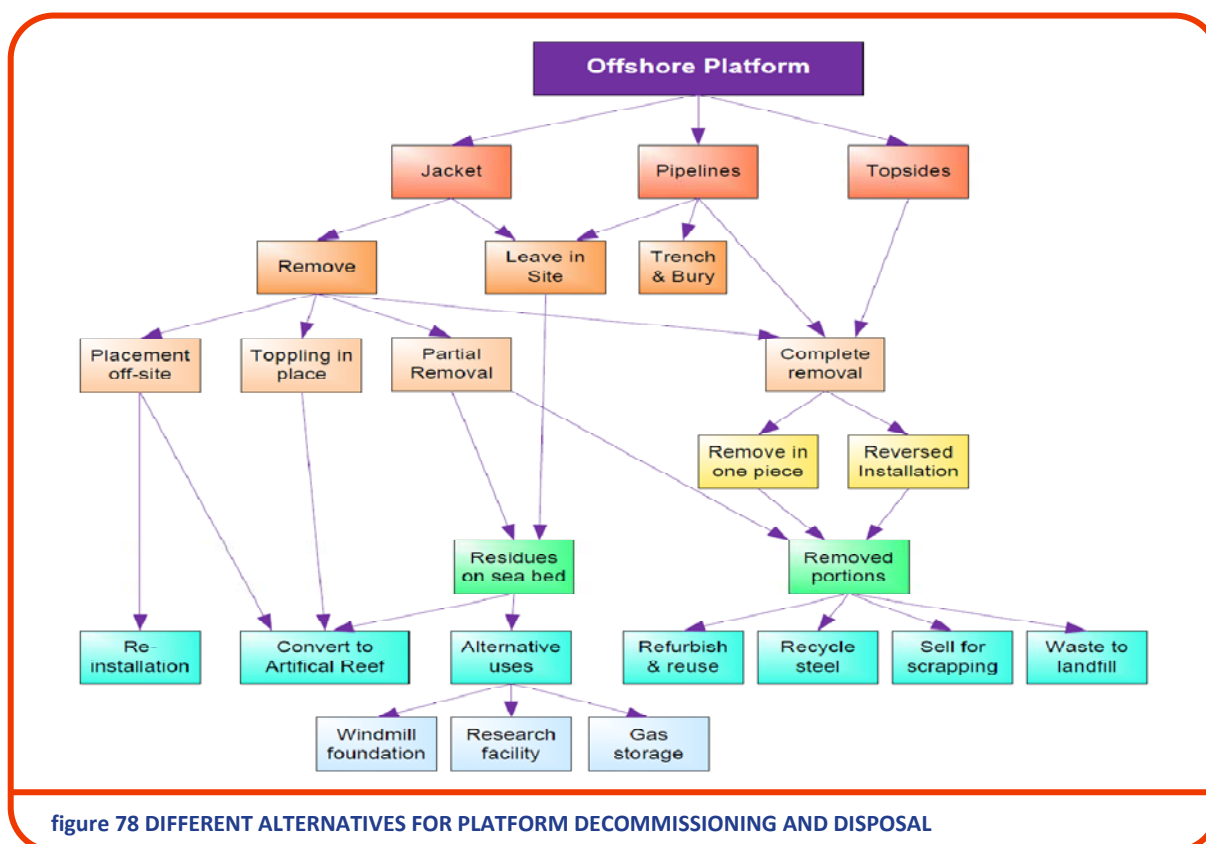
All fixed platforms are custom build for specific field conditions, resulting in a wide range of platform design. However, each structure has several main features that are present on all fixed platforms. Generally, the platform can be split up in the topside structures and the supporting steel jacket structure. As an example of a typical steel platform, the North West Hutton platform will be used located in the Northern North Sea between the UK and Norway (see figure 77).

The North West Hutton platform is an integrated oil drilling, production processing and accommodation facility. The **topside** is composed of 22 separate modules which are connected by several pipelines and electricity cables, in total weighing over 20.000 tons. The main support structure, or **jacket**, is composed an eight-legged steel structure, with vertical and horizontal bracing to provide its overall structural strength. In total weighing over 17.000 tons, the jacket has been fabricated and transported in one peace, launched, positioned over the drilling template and fixed to the seabed using **steel pipes** which penetrate up to 60m underneath the seabed.

Other important characteristics of each fixed platform are the conductors, wells and risers. **Conductors** are the steel production tubes that connect the subsea **wells** to the topsides. These transport the crude oil to the top for further processing. The wells are drilled into the seabed towards the oil field beneath it. Separate wells are connected to each other on the surface by a **steel template** on the seabed. The processed oil is transported from the platform trough several **pipelines** that lie on the seabed. The connection between the topsides and the pipelines on the seabed is called the **riser**, which has its distinctive bend just above the mud line. **Drill cuttings** from installing the supportive pipes and the wells are located underneath or near the jacket structure. These might be contaminated with hydrocarbons and other toxic materials.

As a whole, the platform weighs almost 40.000 tons and is 255m tall. One can imagine that it almost equals the height of the Eiffel tower, but by far exceeds its weight of 7.100 tons. Removing such a structure under the constant shifting and harsh conditions offshore is by any means a challenging and complex operation.

Appendix F: Platform Removal Alternatives



For each fixed platform there are many different scenarios of how the structure will be removed and disposed. Roughly, these scenarios may be divided in removal methods for the topsides, jackets and pipelines. Consideration may use technical, safety, environmental, social and economic criteria to evaluate each disposal alternative. At present, the most common platform decommissioning alternatives fall into four general categories: Complete removal, partial removal, toppling and leave-in-place (see figure 78)

- **Leaving the facility in site:** Obviously the cheapest option is to leave the entire facility in place. As global, regional and national legislation state this removal alternative should be prevent all cases. In only a few cases exception on the general might be considered, because due to structural damage, deterioration or other causes the removal might be too dangerous, difficult or costly to perform.
- **Partial Removal:** Partial removal is only practical where the substructures are located in water deeper than 100 meters. Below this threshold one might leave some parts of the structure in place. After the deck is removed, the jacket is cut below the 100m threshold and removed.
- **Toppling in place:** Toppling the structure in place is similar to partial removal, which implies that the topsides of the facilities will be removed completely and then the substructure can be pulled over to create a reef site. Again, the water depth over the remaining parts will have to be sufficient to allow for safe passing of ships, highly depending on the platforms location. Although many people advocate the success of toppling in the GOM (Rigs to Reef program), toppling is prohibited in the North Sea.
- **Complete Removal:** The complete removal option is the most common and expensive removal option for offshore platforms. To date the completely removed structure were mostly located in shallow waters and posed little difficulty. However, the larger platforms in the North Sea that are currently facing decommissioning are by all means more complex and challenging to be removed completely.

Appendix G: Platform Decommissioning Process

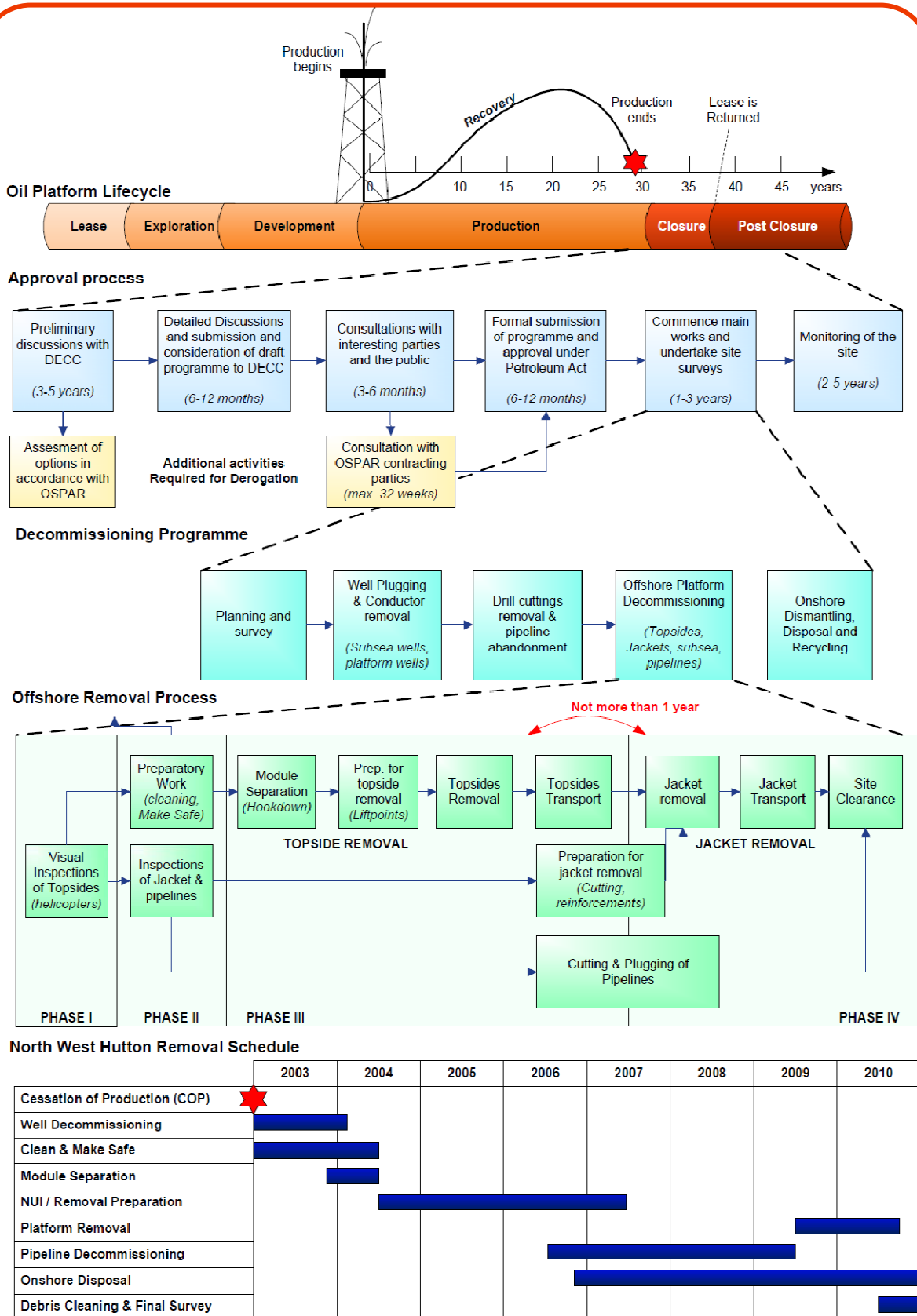


figure 79 TYPICAL PLATFORM DECOMMISSIONING APPROVAL, PROGRAM & REMOVAL SCHEDULE

G.1 Decommissioning Approval process in North Sea

Oil and gas offshore platforms and installation have a limited life of operations. When these platforms reach the end of their lifecycle (on average after 30 years of production), and production levels gradually start declining towards unprofitability, their operators will need to make plans the platform's decommissioning and removal. The operator applies to the government to finish production having proved the reservoir is no longer viable. The government will then issue a "Cessation of Production" (COP) permit.

Up to 5 years in advance of the actual removal operations and COP, platform operators will start the complex "Process of Approval for Decommissioning Programs". During this approval process (which may take over 15 years), operators will go through stages of planning, gaining government approval, and implementing the removal, disposal or re-use of an offshore structure when its final oil producing days are over. (Lakhal, 2008)

According to current Legislation, operators are required to remove structures to such a depth to allow safe passing of shipping in accordance with the IMO guidelines, ensuring a minimum draft of 50m. However, in practice, most of the bigger structures are located in the deeper waters of the North Sea and will have to be removed down to at least a 100m below sea level (Sheehan, 2007). Because the circumstances surrounding individual cases vary greatly, there is no solid and proven way of removing these giant structures. This means that technical, environmental, safety and economic issues will need to be considered carefully in each instance. To ensure the correct assessment and comparison of the various options for platform removal, a predefined consultation and approval process must be followed to balance the many influencing factors. This process of approval is intended to be flexible and transparent, allowing for intensive consultation with stakeholders, the government and the public (O'Conner, 2004).

Legislation provides guidance on how the process of approval and comparative assessment should be undertaken by the operator. In most cases, the process is performed in six different stages starting with preliminary discussions with the governing parties until the monitoring of the site after the platform's removal. As an example, the typical stages in the approval of a fixed platform's complete removal in the UK will be described, outlined by the UK DECC.

G.1.1 Stage 1: Preliminary Discussions with DECC (3-5 years before COP)

In the first stage of the approval process, discussion between the operator and de DECC's Offshore Decommissioning Unit will ensure that timely action is being taken by the operator and that the decommissioning process is well understood. If necessary, other government departments will be involved. In the case of a large production field with multiple facilities, these discussions may commence 3 years or more in advance of de COP. The platform operator is responsible for initiating these discussions. The DECC will give their advise on any particular factors or requirements that need to be taken into account and will encourage the operator to co-operate with other parties to share technical information and experience. During this first stage, agreements will be made on the outline of future events and more detailed discussions and what documentation should be prepared in advance.

G.1.2 Stage 2: Discussions, submission & consideration of draft program (6-12 months)

The second stage involves more detailed discussion of operator's decommissioning proposals and the consideration by other Government parties. With the more straightforward platform structures there may be little distinction between the first and second stage. Conventional platforms in shallow water require only a few meetings before the draft program can be submitted for government consideration. However, the consideration of those cases involving concrete installations or large steel installations with jacket structures weighing over 10.000 tons require a more complex process of discussions. These platforms will need to follow the assessment procedures set out in de the

OSPAR Decision 98/3. If operators seek derogation from the general rule of complete removal and final disposal on land, the application will need to be considered according the rules and requirements set out in this European convention.

G.1.3 Stage 3: Consultations with interested parties and the public (3-6 months)

Transparency and openness is an important aspect of any decommissioning decision, illustrated by the Brent Spar case. The famous Brent Spar is floating storage buoy commissioned in 1976 and taken-out of operation in 1991. The Brent Spar's operator, Shell, proposed the deep-sea disposal of the offshore structure as the most viable option because of the lower technical, operational and safety risks. In 1994, the UK Government approved the proposed program and in May of that year the structure was towed a disposal site on the North Atlantic. However, highly in need of publicity and left out of the process, Greenpeace launches a successful campaign to stop the sea disposal of the Brent Spar, claiming that environmental impact would be greater than stated. Danish, German and Dutch ministers of environment supported the rally in need for Brownie Points. As a result, Greenpeace managed to realize a consumer boycott in Germany against Shell tank stations. This eventually made Shell decide to re-use the structure as a quayside in Norway, one day before the buoy reached its final destination. (POST, 1995)

The Brent Spar case illustrates the importance of external consultations during the consideration of different options for decommissioning. The magnitude of these consultations will be determined by the particular circumstances of each case. In conventional decommissioning cases, statutory consultations will suffice. But in cases of derogation, the operator will need to consult all OSPAR contracting parties and other parties with an interest in the removal procedure.

G.1.4 Stage 4: Formal submission & approval under Petroleum Act (6 months)

Having submitted several draft versions of the decommissioning programme and performed the necessary consultations it should be possible for the operator and the DECC to agree a final versions of the programme. This point is reached in the fourth stage of the approval process where the final programme is submitted by the operator. When approved, the Secretary of State will call formally for the submission and approval of the proposed programme under the 1998 Petroleum Act.

G.1.5 Stage 5: Commence main works and undertake site surveys

The following stage covers the actual implementation of the approved decommissioning program from the initial planning of the activities up to the completion of the final site surveys. The decommissioning program will specify the arrangements by which the DECC is kept informed during progress. Any revisions to the program will be subject to the Secretary of State's approval. At the end of this stage the operator will be required to satisfy the DECC that the approved program has been implemented accordingly. This will in most cases involve the submission of a close-out report within four months of the final offshore operations, including debris clearance and post-decommissioning surveys. The sub processes of the decommissioning program are discussed in the next section of this appendix, G.2.

G.1.6 Stage 6: Monitoring of the site

The final stage of the process will require the operator to implement arrangements for monitoring, maintenance and management of the decommissioned site. Any remains of installations or pipelines are still the responsibility of the operator. The scope and durations of the requirements for post-decommissioning monitoring will be agreed on between the operator and the DECC in consultation with other government departments. It is important to clearly map the remains of the offshore site in order to prevent shipping nets to get stuck on disposed structures.

G.1.7 Additional Activities Required for Derogation

For derogations cases, the aim will be to perform the approval process in a similar matter as in normal cases. However, given the complexities of a derogation case and the additional procedures needed this process may take longer to complete. Because of their complexity, the entire approval process for derogation cases generally starts 5 years in advance of the platforms COP.

In the first phase, the operator will need to consider the assessment of its options in accordance with the OSPAR regulations. At the same time as submitting the draft of the program to the DECC, the operator should start statutory consultations with all interested parties and announce its plans in the press and on the internet. The outcome of these consultations should be included into the draft proposal in addition to comments of the DECC. After a second revision, the operator should consult the ministers for OSPAR derogation and all other OSPAR contracting parties according to the specified process. Having received the updated program, the DECC should be satisfied that there are sufficient grounds to issue a permit allowing derogation from the terms set out in the OSPAR convention.

G.2 Typical Decommissioning program for a fixed platform

The actual decommissioning program is divided into several sub-processes that together deal with the decommissioning and removal of all the facilities on the site, including drill cuttings and pipelines. The different phases of the program are in this sense reflect the removal of the different elements of an offshore production platform. For a large fixed platform like NWH, the entire process may take as long as 8 years. The process can be divided into 5 steps which will be discussed accordingly.

G.2.1 Step 1: Planning & Survey

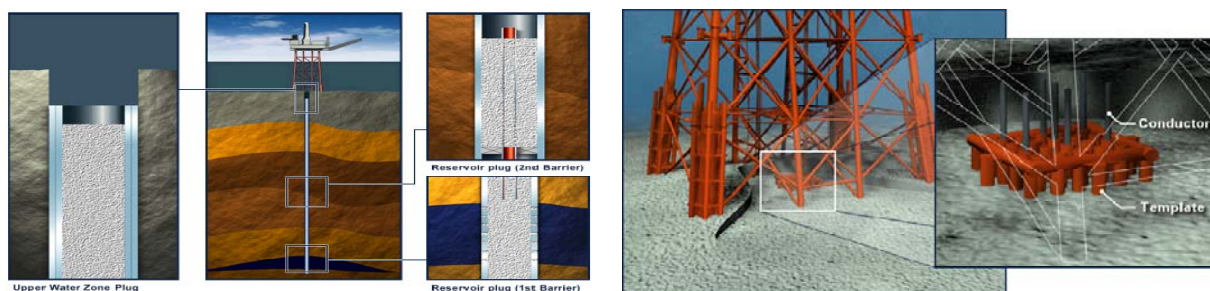
The first part of the actual decommissioning project consists of many site surveys and engineering work to plan the entire project into detail. The exact state of the platform needs to be surveyed to make assumptions on the procedures for cutting and lifting the platform. Many welds will need to be checked because they have experienced the wear and tear of 30 years of offshore operation. These aspects need to be incorporated in the planning of the offshore removal activities.

G.2.2 Step 2: Well Plugging and Conductor Removal

The actual decommissioning of production and injection wells is often the first physical procedure in within the decommissioning program. For fixed platforms, this requires the removal of conductors from the sea-bed to the platform deck, which may also have an effect on the structural status of the platform. The conductors need to be completely removed up to 4,5m below the mud line.

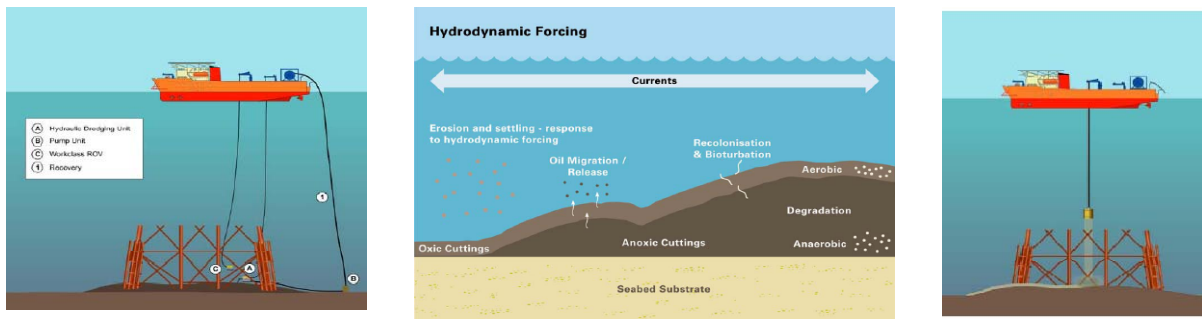
First, the wells are plugged by injecting cement plugs down hole to seal the well-bore and secure it from future leakage while preserving the remaining natural resources. For the NWH project, three separate cement plugs were used to seal the field from its surroundings. The plugging of the wells will be done with a use of the existing platform, before the arrival of the SSCV.

Secondly, a mechanical cutting tool will be run down the hole to cut the case tubing and conductors below the mud line. These are then pulled to the surface by the platform crane and cut into 40-foot-long segments with the use of mechanical cutting methods. The sections will be placed on a workboat for transport to an onshore disposal site. As an example of the duration of the well plugging and conductor removal phase, the NWH operations commenced in May 2002 and were completed in January 2004 with all 40 wells plugged. (BP, 2006)

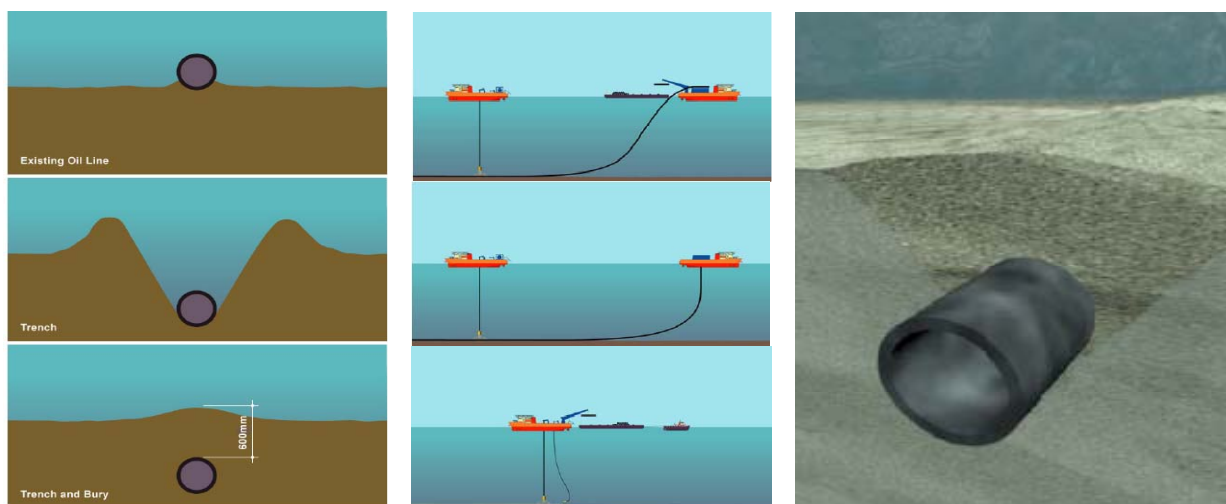


G.2.3 Step 3: Drill Cuttings Removal & pipeline abandonment

Under some platforms there are large mounds of drill cuttings, deposited when the wells were drilled. These mainly exist in the North Sea, where sea-bed currents are not strong enough to have removed them. Currently, there is still a lot of discussion on the removal of the drill cuttings pile. The problem is that it has never been performed before and there is little guidance on what the “best practice” should be (O’Conner, 2004). Many studies are still being performed to assess the different issues, but current regulation treat drill cuttings as a separate issue from that of the decommissioned installations. Cuttings may contain drilling mud material (barite) and hydrocarbons from when oil-based drilling mud was used. The composition, size and nature vary greatly, some piles weighing over 10.000 tons, distributed over hundreds of meters from their original source. This means that for every case one should decide to remove the cuttings or that it would be better to leave them in place and cover them with inert material. Piles might be removed through down-hole injection, or via transfer for processing onshore. The removal should be done as soon as possible in order prevent movement of the cuttings when other operations are executed. When decided to cover the pile for bio-degradation on site, one can perform the operations after the removal to make sure everything is covered properly.



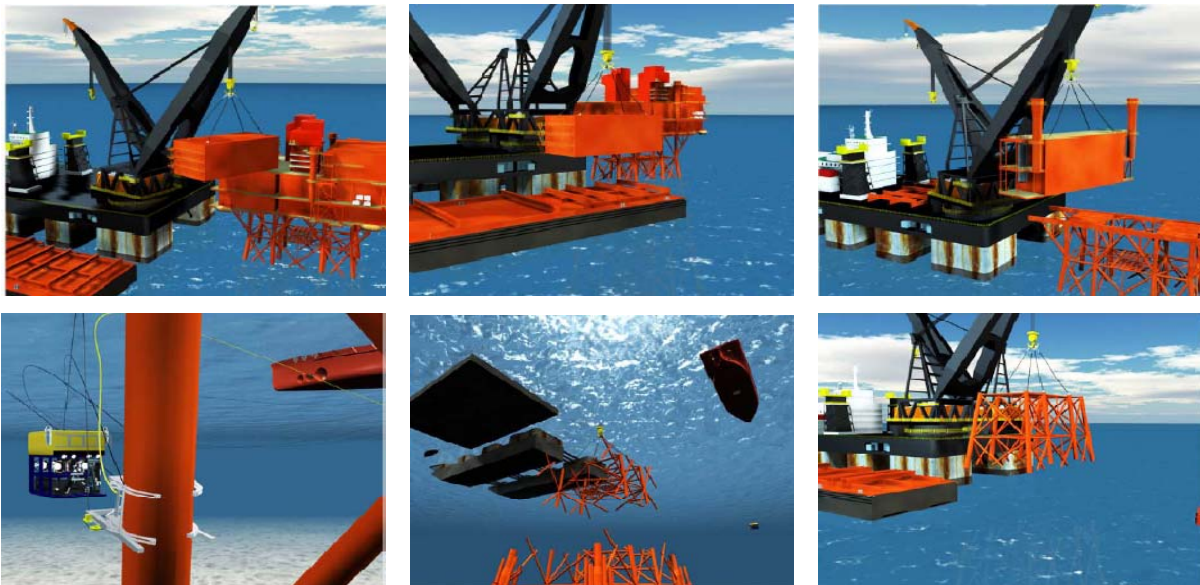
As with drill cuttings, the decommissioning of pipelines within the North Sea is considered on a case-by-case basis. Generally, the larger diameter pipelines may be flushed, plugged and decommissioned on site. Smaller infield and flexible flow lines should normally be removed completely. The process of plugging and cutting the pipeline is performed before the actual removal of the platform commences. First, the pipelines will be flushed and cleaned. Flushing is performed by pumping (and hereby pushing) a cleaning plug (pig) through the line with seawater. Then, depending on the water depth, either divers or an ROV will expose the pipeline and cut the line above the riser-bend and approximately 3m from the base of the jacket. This allows the riser to be removed and the cut end of the pipeline to be plugged. Next, pipelines may be trenched and buried in situ (1m below the seabed) or being completely removed depending on the water depth, condition of the pipeline and the seabed condition. Other issues that influence the decision for removal include overlapping or crossing pipelines, concrete mattresses, spans, sea-bed stability etc.



G.2.4 Step 4: Offshore platform Decommissioning

The offshore removal of fixed platforms is a complicated and difficult procedure which can only be performed during good weather in the summer months. In most cases, the removal process is split up between removal of the topside facilities and removal of the subsea jacket structure. There are several removal methods for the decommissioning of the topsides, which are in detail discussed in appendix F. Generally, the removal process follows the installation process in reverse sequence. The topsides are first thoroughly cleaned and all the piping and electrical lines are cut and removed. Making sure the original modules are separated again is called the “hookdown” procedure. Slings are attached to the lifting eyes on each module, by which the HLV crane can lift each section and lower it on a barge. The modules are then seated on specially designed load spreaders and secured to the deck of the cargo barge (Interview 2, see appendix N).

The Jacket is the most challenging step in the decommissioning process. Most jackets were not designed to be lifted horizontally by a SSCVV. Rather, they were launched up righted in a controlled and planned sequence after which the SSCV placed the jacket on its final destination. This implies that in most cases, the jackets cannot be removed in one piece and must be cut and removed in sections. Several severance techniques are used to cut the jacket into pieces, mostly by using ROV technology. Depending on the removal method and approval for derogation the jacket is cut to a certain depth above the mud line. The separate pieces are then lifted on cargo barges for disposal.



G.2.5 Step 5: Onshore dismantling and disposal and recycling

It is a general requirement that all equipment decommissioned and removed from offshore installations is returned to shore for processing and reuse or disposal. The final step in the decommissioning process is the onshore dismantling and recycling of all structures. There are operators who have considered the reuse option of equipment or jackets, but to this date this has not yet taken place. In most cases, the topsides and jacket will be transferred from the barge to the quayside using high capacity load-out trailers. Specialized contractors will then dismantle the structures with comprehensive material tracking. Dangerous material will be handled by licensed waste contractors. Currently, almost 95% of all material is recycled in reused. (O’Conner, 2004)

G.3 EPRD Offshore Removal Process

As an offshore marine contractor, HMC’s main interest lies in the offshore removal process of platform structures. In the case of the NWH platform, the main preparation, hook-down works and onshore disposal were separately contracted by the client to other parties. Currently, HMC adopted a “one vessel approach”, meaning that HMC takes responsibility for the *Engineering, Preparations,*

Removal and Disposal of the entire platform structure (EPRD project). The typical EPRD process for the removal of a fixed platform consists of 4 separate phases, each performed in a different year.

G.3.1 Phase 1: Platform surveys of topsides by use of Helicopters

During the summer of the first year, a number of visual inspections of the platform will be performed. The platform's topsides will be inspected thoroughly to determine the hook down scope and platform state. This information is crucial to the planning of the offshore process. Because many drawings of platforms are outdated or lost, inspections are needed to check platform data and confirm inventories (Interview 2, see appendix N).

G.3.2 Phase 2: Preparatory work & surveys by use of SSCV as applicable

The second phase is performed during the second year of the project and concerns the "Make Safe" procedure for the topside of the platform. During this procedure access ways are established, hand-rails mounted, fire-fighting equipment installed in order to make sure that the removal work can be performed in a safe way. Most of this work is performed by a subcontractor of HMC, but the HLV vessel will be present to perform important surveys on the top structure and the jacket. The subsea structures and drill cuttings will be analyzed by ROV's. Top structures will be surveyed on structural integrity, contamination with toxic components and presence of asbestos. This makes sure that the number of surprises during the actual removal phase is as low as possible, so HMC uses all the time during the Make Safe procedure to check the platforms state.

During phase 2, HMC will try to perform as much of the Hook Down procedures as possible. This will save a lot of time during the actual removal phase. However, some locations for Hook Down procedures can only be accessed if certain modules have been removed, making it impossible to perform the entire scope during the second phase of the offshore project.

G.3.3 Phase 3: Topside preparation and removal by use of SSCV

The third phase inhibits the removal of the entire topside. HMC will in most cases use the reversed installation method to remove all modules and load them onto cargo barges. This means that the modules first need to be separated, which is the result of the Hook Down process. Where there is no risk of explosion, wires and pipes will be cut using torch cutting and arc gouging. In the case that the pipes are contaminated with flammable material, cold cutting techniques like pneumatic saws or diamond wire methods will be used. Specially designed lifting eyes and pad eyes will be welded to each module so it can be lifted by the SSCV. Then, each module will be lowered onto load spreading grillage mounted on a cargo barge and then "Sea-fastened" for transport to the disposal yard.

In some cases, modules will be lowered onto the SSCV itself because the weather window needed to lower modules on barges is very tight. Then, the SSCV or barge will transport the material to the disposal yard. During the topside removal phase there will be important preparations for the final offshore decommissioning phase: the jacket removal. Pipelines will be plugged, and some cuts to the jackets will already be made during the topside removals. This will save time and effort, making the entire removal more cost effective.

G.3.4 Phase 4: Jacket preparation and removal by use of SSCV

During the final phase of the offshore project, the subsea jacket structure of the platform will be removed. This must be done within one year after the topside removal has been performed. First, the jacket will be prepared for lifting by making planned cuts and welding reinforcements to make sure each piece can be lifted safely. For subsea cutting, remote operated cutting equipment will be used in most cases. The use of explosives is prohibited in the North Sea for environmental reasons. The separate jacket pieces are then lifted and lowered onto cargo barges for transport to the disposal yard. Currently, a concept is developed to lift the jacket in whole and transport it to the yard while hanging from the cranes of the SSCV. This will save a lot of time during the offshore removal, but also heightens the risk of the entire project.

Appendix H: Platform Decommissioning History HMC

The information in this appendix has been removed as it contains confidential information

Appendix I: Case Studies of NWH & Ekofisk EPRD

The information in this appendix has been removed as it contains confidential information

Appendix J: Organization and project structures HMC

The information in this appendix has been removed as it contains confidential information

Appendix K: Risk Management Standards & Literature Review

K.1 International Standards on Risk Management

TITLE	AUTHOR	COUNTRY	RISK AREA	COMMENTS	RISK DEFINITION	PROCESS
BSI PD 6668 <i>Managing Risk for Corporate Governance</i>	British Standards Institution (BSI) – revision by David Smith & Robert Politowski of iMS Risk Solution Ltd	UK YEAR 2000 SCOPE Vision Strategy	Strategic and Operational risk	- Focus on top management level risk - Focus on public sector - Domain specific to Health, Safety, Environmental, Governance and Quality Risk	Hazard x consequence	
BS 6097-3:2000 <i>Project Management – Part 3: Guide to the Management of business-related project Risk</i>	British Standards Institution (BSI)	UK YEAR 2000 SCOPE Strategy Program Project	Business-related Project Risk	- Focus on link of project risks to business objectives and strategies - Roles of perception and stakeholder analysis - Opportunities & threats	Uncertainty inherent in plans and the possibility of something happening that can affect the prospects of achieving business or project goals	A Understanding Context B Identifying risk C1 Analyzing risk C2 Evaluating risk D Treating risk E/F/G Communicate, monitor, review and update plans
AS/NZS 4630:2004 <i>Risk Management (Third edition)</i>	Standards Australia / Standards New Zealand	AS / NZS YEAR 2004 (revision of 1995 & 1999) SCOPE Program Project	Business-related Project Risk	- Focus on link of project risks to business objectives and strategies - Roles of perception and stakeholder analysis - Opportunities & threats	Uncertainty inherent in plans and the possibility of something happening that can affect the prospects of achieving business or project goals	A Understanding Context B Identifying risk C1 Analyzing risk C2 Evaluating risk D Treating risk E/F/G Communicate, monitor, review and update plans
IEEE Standard 1540-2001 <i>Standard for Software Life Cycle Processes – Risk Management</i>	Institute of Electrical and Electronic Engineers USA	USA YEAR 2001 SCOPE Strategy Program Project	Project and Organizational risk in software projects	- Specifically designed for software	The likelihood of an event, hazard, threat or situation occurring and its undesirable consequences; a potential problem	A Plan risk management B Risk identification C1 Risk estimation C2 Risk evaluation D Risk treatment G Risk monitoring H Evaluate RM process
CIE/IEC 62198:2001 <i>International standard, Project Risk Management: Application Guidelines</i>	International Electro technical Commission, Switzerland	CH YEAR 2001 SCOPE Project Tasks	Project risk Technological risk	- Focus on projects with a technological content but may also be applied to other projects	Combination of the probability of an event occurring and its consequences on project objectives	A Establishing the context B Risk identifications C Risk assessment D Risk treatment F/G Risk review and monitoring H Post-Project
JIS Q2001:2001 (E) <i>Guidelines for Development and Implementation of Risk Management System</i>	Japanese Standards Association	JPN YEAR 2001 SCOPE Strategy, Program	Organizational risk and operational risk	- Guide for developing an organizational management system concerned with risk	A combination of the probability of an event and its consequence	A Organizational structure B Risk Identification C1 Risk Estimation C2 Risk Evaluation D Risk treatment F Program implementation G Monitoring H Evaluation of RM
CAN/CSA-Q859-97 <i>Risk Management: Guideline for Decision-Makers</i>	Canadian Standards Association	CAN YEAR 1997 SCOPE Strategy, Program	Organizational risk and Operational risk, Safety risk	- Emphasis on risk communication at all steps of process - Emphasis on stakeholder collaboration	The chance of injury or loss	A Initiation B Identifying hazards C1 Risk estimation C2 Risk evaluation D Risk Control G Monitoring process H Evaluation of RM

TITLE	AUTHOR	COUNTRY	RISK AREA	COMMENTS	RISK DEFINITION	PROCESS
M_o_R 2007 <i>Management of Risk – Guidance for practitioners (Second edition)</i>	UK Office of Government Commerce (OCG)	UK	Strategic, project, operational risk	<ul style="list-style-type: none"> - Chapters on management of risk principles and embedding and reviewing management of risk - Part of a larger suite of methods including managing successful programmes and PRINCE2 	An uncertain event or set of events that, should it occur, will have an effect on the achievement of objectives. A risk is measured by a combination of the probability of a perceived threat or opportunity occurring and the magnitude of its impact on objectives	A Identify – Context B Identify – Identify the Risks C1 Assess – estimate C2 Assess – evaluate D Plan F Implement G Embed and review (E) Communicate
		YEAR				
		2007 (revision of 2002)				
		SCOPE				
ISO 31000 <i>Risk Management – Principles and Guidelines on application</i>	International Organizations for Standardisation (ISO)	-	General risk	-	Risk is the combination of the probability of an event and its consequences	A Establishing the context B Risk Identification C Risk Assessment D Risk Treatment E Create a Risk management plan (RMP) G Review RMP H Evaluate RMP
		YEAR				
		2009				
		SCOPE				
RISMAN-methode	Gemeente Rotterdam ProRail RWS Bouwdienst RWS Zuid-Holland TU Delft Twynstra Gudde	NL	Project Risk and Organizational Risk	Infrastructure project estimations	Chance of threat multiplied by effect in euro's	B/C Integral Risk Analysis D Define responses E Implement responses G Evaluate responses G Review risk analysis
		YEAR				
		1992				
		SCOPE				

K.2 Professional standards on risk management

TITLE	AUTHOR	COUNTRY	RISK AREA	COMMENTS	RISK DEFINITION	PROCESS
IRM/ALARM/AIRMIC <i>Risk Management Standard</i>	Institute of Risk Management (IRM) / National Forum for Risk Management in the Public Sector (ALARM) / Association of Insurance and Risk Managers (AIRMIC)	UK	Strategic risk, business risk and operational risk	<ul style="list-style-type: none"> - Adopted by Federation of European Risk Management Association in 2003 (FERMA) - Specific attention to roles and functions of individuals in the organization - Gives tools for developing corporate risk map 	The combination of the probability of an event and its consequence	A The organization's strategic objectives B Risk identification C Risk description C Risk estimation C Risk evaluation E Risk reporting D Risk treatment G Monitoring and review
		YEAR				
		2002				
		SCOPE				
COSO <i>Enterprise Risk Management – Integrated Framework</i>	Committee of Sponsoring Organizations of the Treadway Commission (COSO)	USA	Strategic risk, business risk and operational risk	<ul style="list-style-type: none"> - Focuses on internal organizational risk taking - Focuses on high level risk taking for long term enterprise development 	Event with a negative impact, which can prevent value creation or erode existing value.	A Internal environment analysis A Objective Setting B Event Identification C Risk Assessment D Risk Response ? Control activities E Information and communication G Monitoring
		YEAR				
		2004				
		SCOPE				
Project risk management Handbook (threats and opportunities)	Office of Statewide Project Management Improvement (OSPMI)	USA	Project risk management in transportation	- Practical guide for project risk management in the California DoT	An uncertain event or condition that, if it occurred, would have a positive or negative effect on a project's objectives	A Risk management planning B Risk identification C1 Qualitative risk analysis C2 Quantitative risk analysis D Risk response planning E Risk monitoring and control
		YEAR				
		2007				
		SCOPE				

TITLE	AUTHOR	COUNTRY	RISK AREA	COMMENTS	RISK DEFINITION	PROCESS
PRAM <i>Project Risk Analysis & Management Guide, (Second edition)</i>	Association for Project Management (APM)	UK YEAR 2004 (revision of 1997) SCOPE Project Tasks	Project risk	- Includes chapters on benefits of RM, establishing a risk management organization, behavioral aspects and implementation / application issues - Threats and opportunities - Risk defined at two levels, risk event and project risk	Risk Event: An uncertain event or set of circumstances that, should it or they occur, would have an effect on the achievement of one or more of the project's objectives Project Risk: The exposure of stakeholders to the consequences of variations in outcome	A Initiate (define & focus) B Identification C Assessment D Plan Responses E Implement responses ? Manage process
ANSI 99-001-2004 PMBOK <i>Guide to the Project Management Body of Knowledge: Chapter 11, Project Risk Management (Third edition)</i>	Project Management Institute (PMI)	USA YEAR 2004 (revision of 1996 & 2000) SCOPE Project Tasks	Project risk	- Strong process orientation (inputs/tools and techniques/outputs) - Addresses Opportunities & threats	An uncertain event or condition that, if it occurred, would have a positive or negative effect on a project's objectives. Where project risk is an uncertain event or condition, if it occurs, has a positive or negative effect on at least one project objective such as time, cost, scope, or quality.	A Risk management planning B Risk identification C1 Qualitative risk analysis C2 Quantitative risk analysis D Risk response planning E Risk monitoring and control
RSKM <i>CMMI Risk Management Process</i>	Software Engineering Institute (SEI)	AS YEAR 2002 SCOPE Vision, Strategy, Program, Project	Organizational, Operational, Business and Project risk in software projects	- Specifies different maturity levels within the risk management process		A Establish RM strategy B Identify Risks C Analyze Risk D Plan risk Responses G Track and monitor risks ? Control Risk Mitigation
RAMP <i>Risk Analysis and Management for Projects, (Second Edition)</i>	Institution of Civil Engineers (ICE)	UK YEAR 2005 (revision of 2002) SCOPE Strategy Program Project	Focuses on strategic and project risks in large construction projects	- Considers opportunity and threats - Focus is on whole life assets, with emphasis on large capital projects	A threat (or opportunity) that could affect adversely (or favorably) achievement of the objectives of an investment	A Process launch B Plan and initiate risk review B Identify risks C Evaluate risks D Devise measures for responding to risks D Assess residual risks and decide whether to continue D Plan responses to residual risks E Communicate risk response strategy and response plan F Implement strategy and plans G Control risks H Process closedown

K.3 Practical Guidelines and books on project risk management

TITLE	AUTHOR	COUNTRY	YEAR	COMMENTS	RISK DEFINITION	PROCESS
<i>Project Risk Management, Processes, Techniques and Insights (second edition)</i>	Chris Chapman and Stephan Ward (University of Southampton)	UK	2004 (revision of 1996)	- Focus on decision making under risk - Focus on risk management as an add in to project management	The possibility of adverse departures from expectations	A1 Define A2 Focus B1 Identify B2 Structure B3 Ownership C1 Estimate C2 Evaluate D Plan G Manage

TITLE	AUTHOR	COUNTRY	YEAR	COMMENTS	RISK DEFINITION	PROCESS
<i>Practical Project Risk Management, The ATOM Methodology</i>	David Hillson (Director of Risk Doctor & Partners) & Peter Simon (Managing Partner of Lucidus Consulting Limited)	UK	2007	-Totally Scalable -Can be used on all projects -Practical “how to” methodology	Any uncertainty that, if it occurred, would have a positive or negative effect on achievement of one or more objectives	A Initiation B Identification C1 Assessment C2 (Quantitative risk analysis) D Response planning E Reporting F Implementation G Review H Post-project review
<i>Project Risk Management Guidelines</i>	Dale Cooper, Stephan Gray, Geoffrey Raymond and Phil Walker Broadleaf Capital International (BCI)	AS	2005	-Focus on large projects and complex procurements	Risk is exposure to the consequences of uncertainty	A Context B Risk Identification C Risk Assessment D Treatment G Monitor and Review
<i>Risk Management in projects (second edition)</i>	Martin Loosemore, John Raftery, Charlie Reilly, Dave Higgon (University of New South Wales)	AS	2006 (revision of 1993)	-Focus on developing a risk management system -Broad evaluation of risk analysis tools -Addressing psychological aspects of risk management	Unpredictable events that might occur in the future whose exact likelihood and outcome is uncertain but could potentially affect interests/objectives in some way	B Risk Identification C Risk Analysis D Risk Control
<i>Reducing Project Risk</i>	Ralph L. Kliem & Irwin S. Ludin	USA	1997	-	Occurrence of an event that has consequences for, or impacts on, projects	B Risk identification C Risk Analysis D Risk Control E Risk reporting

K.4 Risk Management Chapters in Project Management Literature

TITLE	AUTHOR	COUNTRY	YEAR	CH.	RISK DEFINITION	PROCESS
Project Management – A systems approach to planning, scheduling and controlling (Eighth edition)	Harold Kerzner	US	2003	17	Risk is a measure of the probability and consequences of not achieving a defined project goal	A Risk Planning C Risk Assessment D Risk Handling E Risk Monitoring
Project Management for Business and Technology – principles and practice (Second Edition)	John. M. Nicholas	CAN	2004	10	Risk is a joint function of the likelihood that some problematical event will occur and the impact of the event if it does occur	B Risk Identification C Risk Assessment D Risk Response Planning
The Project Workout – A toolkit for reaping the rewards from all your business projects (Third edition)	Robert Buttrick	UK	2005	24	Any potential uncertainty, threat, or occurrence which may prevent you from achieving your defined business objectives. It may affect timescale, cost, quality or benefits.	B Identifying Risks C Asses Risks D Treat Risks E Monitor Risks
AMA Handbook of project management (second edition)	Paul C. Dinsmore and Jeannette Cabinis-Brewin; American Management Association (AMA)	USA	2004	14	An uncertain event or condition that, if it occurred, would have a positive or negative effect on a project’s objectives	A Risk management planning B Risk identification C1 Qualitative risk analysis C2 Quantitative risk analysis D Risk response planning E Risk monitoring and control
Project Management – a Managerial Approach (sixth edition)	Jack R. Meredith and Samuel J. Mantel	USA	2006	4.6	The expected value of an action is the sum of the values of each outcome associated with the action times the probability that it will occur. The course of action can be selected associated with the best of these expected outcomes. This is decision making under conditions of risk.	A Risk management planning B Risk identification C1 Qualitative risk analysis C2 Quantitative risk analysis D Risk response planning E Risk monitoring and control

Appendix L: NWH Project Evaluation (schedule/cost)

The information in this appendix has been removed as it contains confidential information

Appendix M: Analysis of HMC Risk Management

The information in this appendix has been removed as it contains confidential information

Appendix N: Overview of Case Interviews

table 40 Overview of case interview

NR	NAME	FUNCTION	DEP	CASE	TYPE	DATE	TIME
1	Machiel Penning	Risk Coordinator	LEGAL	NWH/Ekofisk	Explorative / Semi-structured	19/02/09	09:00 – 10:00
2	Jan Groot	Project Manager	PM	NWH	Explorative / Semi-structured	24/02/09	16:00 – 17:00
3	Richard Zoontjes	Weather Risk Analyst	TECH	NWH/Ekofisk	Explorative / Semi-structured	25/02/09	11:00 – 12:00
4	Peter Landsweers	Planning Manager	PLAN	-	Explorative / Semi-structured	25/02/09	13:00 – 14:00
5	Jim Knight	Manager QESH	QESH	Ekofisk	Explorative / Semi-structured	26/02/09	15:00 – 16:00
6	Pim Scharstuhl	Project Controller	FIN	NWH	Explorative / Semi-structured	02/03/09	11:00 – 12:00
7	Peter Sabel	Planner	PLAN	NWH	Explorative / Semi-structured	02/03/09	16:00 – 17:00
8	Hans Marges	Project Director – Project Ekofisk	PM	Ekofisk	Explorative / Semi-structured	04/03/09	10:00 – 11:00
9	Erik van Binsbergen	Planner & Risk Analyst	PLAN	Block 31	Explorative / Semi-structured	05/03/09	12:00 – 13:00
10	Ronald van Waaijen	Tender Manager	TEN	Ekofisk	Explorative / Semi-structured	06/03/09	13:30 – 14:30
11	Arjan Kraaieveld	Project Director – Tender Ekofisk	PM	Ekofisk	Explorative / Semi-structured	12/03/09	10:00 – 11:00
12	Erwin Scheffers	Sr. Project Controller	FIN	Ekofisk	Explorative / Semi-structured	24/03/09	15:00 – 16:00
13	Theo Houtman	Sr. Tender Manager	S & BD	-	Explorative / Semi-structured	24/04/09	11:00 – 12:00
14	Jan Gravekamp	Project Manager Offshore	PM	Ekofisk	Explorative / Semi-structured	25/04/09	10:00 – 11:00
15	Gert Hofland	Manager Prospects	S & BD	-	Explorative / Semi-structured	27/04/09	16:00 – 17:00
16	Peter de Bree	Manager of Projects	PM	-	Explorative / Semi-structured	19/05/09	14:00 – 15:00
17	Piet Boellen	Manager Finance	FIN	-	Explorative / Semi-structured	20/05/09	11:00 – 12:00
18	Simon Szkudlarek	Project Manager Subcontracts	PM	Ekofisk	Explorative / Semi-structured	21/05/09	14:00 – 15:00
19	Machiel Penning	Risk Coordinator	LEGAL	NWH/Ekofisk	Reflective / Structured	04/06/09	09:00 – 11:00
20	Arjan Kraaieveld	Project Director – Tender Ekofisk	PM	Ekofisk	Reflective / Semi-structured	05/06/09	15:00 – 16:00
21	Jan Groot	Project Manager	PM	NWH	Reflective / Structured	09/06/09	15:00 – 17:00
22	Peter de Bree	Manager of Projects	PM	-	Reflective / Semi-structured	17/06/09	12:30 – 14:00
23	Edwin de Korte	Procurement Manager	PROC	Ekofisk	Reflective / Semi-structured	07/07/09	16:00 – 17:00
24	Ronald van Waaijen	Tender Manager	TEN	Ekofisk	Reflective / Semi-structured	13/07/09	11:00 – 12:00
25	Ronald Aardse	Operational Manager	OPS	NWH	Reflective / Semi-structured	30/07/09	09:00 – 10:00
26	Alan Paige	Project Manager	PM	NWH	Reflective / Semi-structured	30/07/09	14:00 – 15:00
27	Bas Breman	Project Engineer	TECH	NWH/Ekofisk	Reflective / Semi-structured	28/08/09	10:00 – 12:30
28	Piet Boellen	Manager Finance	FIN	-	Reflective / Semi-structured	02/09/09	12:00 – 13:00
29	Erwin Scheffers	Senior Project Controller	FIN	Ekofisk	Reflective / Semi-structured	04/09/09	16:00 – 17:00

