Benchmarking Risk Management for Exploration and Production Capital Projects

Master Thesis

by

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Scope of Work

BSc. **Peter MAXWELL** was requested to analyze in the master thesis at hand the topic:

„ Benchmarking Risk Management for Exploration and Production Capital Projects “

All exploration and production projects have significant uncertainties and at least some of these generate substantial risks. Understanding, quantifying and knowing how to manage these risks and uncertainties is in today's turbulent business environment indispensable. Based on this fact this master thesis pursues the main goal to identify best practices and lessons learnt from the implementation of risk management in exploration and production capital projects.

The theoretical part of the thesis has to review the literature, which is necessary to work on the given topics. This should include an introduction to risk management and risk assessment techniques. Representative case studies and the specific case of an industry partner should also be used to demonstrate how risk management is carried out in the industry. Furthermore overviews about survey methods and benchmarking have to be delivered.

Within the empirical part of the thesis the current status of the risk management in the oil and gas industry has to be elaborated by a survey. This should take in account the organization of risk management in the business: responsibilities, structure, knowledge management, methods and software tools. In addition respondends personal interpretations about actual barriers and future trends have to be captured. Informations gained through this study have to be analysed and summarised. The combination of these results with the theory should enable then the identification of best practices. Finally a comparison between the best practice and the industry partner must take place, so that recommendations for improving risk management in the company can be provided.

Leoben, November 2012

o.Univ.Prof. Dr. Hubert Biedermann

Affidavit

I declare in lieu of oath, that I wrote this thesis and performed the associated research myself, using only literature cited in this volume.

_____ _____

Place/Date (Peter Maxwell)

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Notation

OMV	Österreichische Mineralölverwaltung
HSEQ	Health, Safety, Environment, Quality
PMI	Project Management Institute
PMBOK	Project Management Body Of Knowledge
CAPEX	Capital Expenditures
OPEX	Operation Expenditures
E&P	Exploration & Production
ADM	Asset Development Manager
ERM	Enterprise Risk Management
SME	Small & Medium Enterprises
TECOP	Technical, Economical, Commercial, Organizational & Political
FID	Final Investment Decision
HAZOP	Hazard and Operability study
ALARP	As Low As Reasonably Practicable
AWARE	Advised Workflow for Accurate Risk Estimates
HAZID	Hazard Identification
P.E.A.R.	People, Assets, Environment and Reputation

Abstract

All exploration and production projects have significant uncertainties and at least some of these generate substantial risks. Understanding, quantifying and knowing how to manage these risks and uncertainties is in today's turbulent business environment indispensable. Based on this fact this master thesis pursued the main goal to identify best practices and lessons learnt from the implementation of risk management in exploration and production capital projects.

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1 Introduction

The oil and gas industry has always been strongly linked to risk and uncertainty. Geological, political, technical, financial or currency-related aspects are some of the most common risks and uncertainties the industry needs to focus on. Nowadays declining production of conventional resources, new unconventional resources, new technologies, stricter regulations within HSE, increasing taxes as well higher stakeholder expectations make entrepreneurial operations -and thus projects which are a part of these- more and more difficult to manage. Risks and uncertainties in projects, whenever they occur, can lead to project failure, boosting project costs or significant increase of project duration or both. Therefore, risk management has become a crucial asset within project management, gaining more and more importance on project level and is nowadays a completely incorporated process within large capital projects. Project risk management is an integral[1] portion of project management, is considered as a critical factor for project success.

In order to control and supervise this environment with risks and uncertainties, project management uses structures and disciplined techniques and tools. The project manager and project team lead the risk management process, by identifying project risks, analyzing and ranking them, and determining what actions need to be taken to reduce the threats. This risk assessment lasts throughout the whole project lifecycle. Efficient management of risks can lead to positive outcome of a project in terms of costs, time as well as quality.

During the process of performing risk management, best practices and lessons learned are captured. These may support the following steps of the same risk management process or may be available for other, similar projects in the future. By having access to this knowledge, positive impacts may be forced. The impacts may be:

- The correct allocation of resources. Providing an adequate budget or sufficient time for risk management tasks. How to plan the strategy of a given project, for instance developing the right risk management plan
- Understanding the impact of changes in scope
- Delivering adequate reports to stakeholders

Therefore, whenever results, data and learnings from risk management are used, the success rate and efficiency will be higher.

Goals of this study

A variety of studies concerning risk management in the oil and gas industry are carried out but these are conducted on an enterprise wide level, neglecting the importance of risk management on the project level. The aim of this Master thesis is to investigate the current state of risk management practices for exploration and production capital projects by means of an industry-wide survey. Therefore, this survey should provide answers about the extent of project risk management, people in charge, methodologies as well as tools. In order to gain better understanding, it will be important to detect what main barriers stand in the way of implementing an effective risk management system.

An actual perception as well as future trends will be captured in order to make a general comparison of where we are and where we would like to be in the future.

[1] Haseeb M., et al., 2014, P. 134

In detail, the objectives of the empirical research are as follows:

- To reveal what are the critical factors (enterprise size, knowledge of responsible) that effectively define a company's approach to managing risk.
- Study the formal techniques of risk management, in particular the techniques/methodologies which are used in the several phases of the risk management process of risk identification, risk evaluation and risk monitoring.
- To investigate the organization of risk management, such as the responsibilities for implementing and maintaining it, as well as the application of international risk management standards.
- To examine the handling of single projects with respect to their contribution to the risk profile of the entire enterprise. We will especially focus on the topic of project risk management; therefore it will be necessary to investigate which techniques are applied for risk identification and the evaluation of project risks.
- To provide recommendations on how companies/organizations may improve their project risk management practice and on the development of a framework for their risk management.

Structure

This work will be divided into two parts, a theoretical part and a practical part including a survey which has been conducted within the E&P industry. The theory will include the literature review about risk management and benchmarking, as well as various case studies reporting about the use of project risk management and the used methodologies. The practical part will describe the conducted survey about project risk management within the E&P industry, where various risk management professionals have been asked to deliver insights about the related topic.

This work will identify benchmarks, in order to define the most important criteria to efficient project risk management. Topics such as methodologies, knowledge management, qualifications as well as barriers will be deeply discussed; evaluating how companies deal with these themes will provide crucial information.

Towards the very end of this thesis, after combining theoretical input with industry wide benchmarks and based on the result of this work, a recommendation will be provided, which may act as a guideline by presenting a selection of success factors to any risk management process.

2 Literature research – Project Risk Management

2.1 Introduction to Project Risk Management

"Organizations of all types and sizes face internal and external factors and influences that make it uncertain whether and when they will achieve their objectives. The effect this uncertainty has on an organization's objectives is called risk."[2]

Project risk management deals with the processes of planning, identifying, evaluating, responding to and monitoring project risks. Business environments are developing in a way that complexity, dynamism and efficiency are increasing, which requires clean and effective internal systems such as risk management systems.[3] The aim is to control and manage the existing and future risks of a company so that, given reduced risks and continuing opportunities for earning, the value of a company increases and that there is an assurance that the risk position of a company does not exceed its risk-bearing ability (the ability of the company to bear losses arising from the risks it has entered into without becoming insolvent).[4]

In order to successfully pass all project phases, it is necessary to deal with risk management. Actions within any capital project may contain uncertainty and risks (example: On-time delivery of building materials), explaining the need of a suitable risk management in order to have adequate treatment of threats or opportunities. While the consequences of threats are a decrease of chance of success, opportunities increase the chance of success of a project.

A risk may be completely avoided. Nevertheless, the objective of risk management is not to clean up all the threats, but to decrease the probability of an event which could jeopardize the success of a project. Also, the goal is to increase the probability of an opportunity. The main idea is to find the right balance between the impact if the risk might ever occur, the probability of occurrence and cost of treating the risk. It would make no sense to spend enormous sums of money and much time on trying to avoid a risk, which would have a minimal impact on the outcome of a project.

Risk management in the E&P industry is performed in various areas such as for project management, HSEQ, for finances etc. It defines the whole task around treating risks and opportunities, how the planning processes will be approached and it identifies which activities will take place. Although the three main areas are general classifications, single risks are assigned to one of these categories which are based on standards of the industry or set by the company itself. Trends can be spotted, which helps the identification of risks.[5]

At OMV

Large companies such as **OMV** need standards which basically are documents providing guidelines and rules for a number of activities. Terms are defined, so that there does not exist any misunderstandings between individuals within the company.

OMV has set a standard regarding Project Management which includes some key definitions, guidelines and key elements. For the Risk Management Process, some key elements with leading questions have been pointed out, which are:

[2] ISO 31000, 2009, P. 5
[3] Sherrer, J., 2010, P. 351
[4] Henschel, T., 2008, P. 6
[5] Sherrer, J., 2010, P. 351

- Risk Identification: Which risks exist? What are their characteristics? In which phases or work packages may they appear?
- Impact: Which effect does the risk have on scope, quality, time and cost? What is the effect of the risk on day-to-day company business and the company interests outside of the project itself? Financial damage caused by the risk?
- Probability of Occurrence: What is the probability that the risk will actually happen? 0-10% is a negligible risk ("can happen, but in reality almost never happens"), 11-40% is a medium risk ("It does not happen very often, but it does happen"), 41-60% is a high risk which can be assumed to occur, and over 61% is a very high risk where problems can be expected.
- Preventive Measures: Designed to minimize the probability of risk occurrence and to reduce the impact of risks. Preventive means that the measures are implemented before the effect. Implementation of measures requires resources and project planning with regard to cost and schedules.
- Reactive Measures: Implementation of measures once the risk has occurred. Planning of measures upon occurrence of risk. Modification of project plan. Emergency scenarios and costs.
- Controllability: Showing to which extend the risk exists.
- Cost of Risks: Cost of the damage.
- Expected Cost: Cost of risks x Probability of occurrence.
- Cost of Risk Provision: Cost of preventive measures.[6]

Assigning likelihoods to risks or accepting a remaining risk, also called residual risk can be different according to the size of the capital project and the philosophy of the organization.

Furthermore, **OMV** has a standard which is defined in a master document called "Project Risk Management Standard for Capital Projects", and all projects have to follow the guidelines given throughout that paper. We will later on see and discuss the content of this standard.

Key Definitions

In Theory

Before going into details about the procedures within risk management with the methods and tools that come along, one needs to define the term "risk". There are many different definitions, over 100 different regulations and standards currently exist to risk and risk management, such as the one of ISO 31000 where a risk is an "effect of uncertainty on objectives", with effects being positive or negative deviations from the expected.[7] The definition of a risk in the PMBOK Guide, a standard published by the Project Management Institute, is being an "uncertain event or condition that if it occurs, has a positive or negative effect on a project's objectives."[8]

[6] Hütter K., 2009, P. 85
[7] ISO-31000:2009, P. 1
[8] PMI, 2008, P. 2

In a more detailed definition, a risk "is a situation wherein all possible outcomes and the probability of occurrence are known, even as one does not know which outcome shall surely occur.

- Addresses discrete events (e.g. discovery or dry hole)
- Can be both: A threat or an opportunity"[9]

Other definitions are:

- "Risk: The probable frequency and probable magnitude of future loss"[10]
- "Risk is the potential that a given threat will exploit vulnerabilities of an asset or group of assets and thereby cause harm to the organization"[11]

Uncertainties are defined for example as "situations wherein the possible outcomes or probabilities of the outcomes are unknown, or both the possible outcomes and probability of outcomes are unknown.

- Result depends on unknown circumstances (e.g. oil price)
- Occurrence probability of an event is not quantifiable".[12]

It must be mentioned that we are nowadays encountering a problem with the great amount of definitions of risk and uncertainties. There is no single universal definition. There are many varying and mistakable definitions, which lead to a globally wide confusion. This furthermore leads to a great amount of different approaches. We will rely on the PMBOK definition of risk given above, which remains simple and relevant for the topic of this thesis.

The term "probability" can be understood as a "degree of confidence" according to Jacob Bernoulli, to which one attaches an uncertain event with a degree varying from individual to individual depending on the individual knowledge.[13]

Furthermore, based on the ISO standards, other key terms and definitions are of importance for the continuation of this work. These definitions are:

- Risk management: the coordination of all activities to direct and control an organization with regard to risk.
- Risk attitude: the approach of a company to assess and eventually pursue, retain, take or turn away from risk.
- Stakeholder: person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity.
- Risk Assessment: within the standard of ISO 31000 and ISO 31010, the term risk assessment stands for the categories of risk identification, risk analysis and risk evaluation.
- Risk source: an element which can come alone or in combination with other elements to give rise to a threat or opportunity.

[9] Ezendu, E., 2010, P. 7
[10] Jones, J.A., 2005, P. 8
[11] ISO/IEC-27005:2008, 2008, P. 3
[12] Ezendu, E., 2010, P. 7
[13] Macmillan, F., 2000, P. 21

- Event: occurrence or change of a particular set of circumstances.
- Consequence: outcome of an event affecting objectives.
- Likelihood: chance of something happening, also called probability.
- Risk profile: description of any set of risks.
- Risk analysis: process to comprehend the nature of risk and to determine the level of risk
- Risk criteria: terms of reference against which the significance of a risk is evaluated.
- Level of risk: magnitude of a risk or combination of risks, expressed in terms of the combination of consequences and their likelihood.
- Risk evaluation: process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude are acceptable or tolerable.
- Risk treatment: process to modify risk.
- Risk control: measure that is modifying risk.
- Residual risk: risk remaining after risk treatment.
- Risk monitoring: continual checking, supervising, critically observing or determining the status in order to identify change from the performance level required or expected.
- Risk review: activity undertaken to determine the suitability, adequacy and effectiveness of the subject matter to achieve established objectives.[14]

At OMV

Project risks may be present today or can occur in the future. A project risk is an "uncertain event or condition that, if it occurs, has a negative (threat) or positive (opportunity) effect on at least one project objective (such as safety, scope, cost, quality and schedule)." Risks should be as much as possible differentiated from uncertainties and issues. An uncertainty is associated with price regimes (i.e. crude oil, product prices), market forecasts, weather, subsurface or similar topics. Usually uncertainties are communicated and accepted by the project as soon as the project is kicked off.

The table below shows some examples for threats and opportunities.

Theme	Threat	Opportunity
Nature	A snowstorm may affect the level of difficulty to work outside or makes it impossible to get to work.	Good weather may accelerate the construction Because of less rainy/stormy days then expected
Financial	Price raise for materials	low rent opportunity due to sharing of the location
Technical	Innovation means higher costs and engineering Risks	New infrastructure enhances efficiency, new computers accelerates communication and workflow

Table 1: Threats vs. Opportunities[15]

[14] ISO 31000, 2009, P.15

A project risk, that has already occurred, is regarded as an issue. It is useful to consider project risks at two levels – as individual risks and the overall project risk. Individual risks are specific events or conditions that might affect project objectives. Day-to-day project risk management focuses on these individual risks in order to enhance the prospects of a successful project outcome. The overall project risk represents the effect of uncertainty on the project as a whole. The overall project risk stands for the exposure of stakeholders to the implications of variations in project outcome and is an important component of strategic decision-making, portfolio management and project governance where investments are sanctioned or cancelled and priorities are set.[16]

2.2 Roles in Risk Management

In Theory

A project in which risk management is required needs key people with given roles and responsibilities. According to PMI as well as ISO, these key roles are:

- The Project Manager: He is the head of the project. He is responsible for the entire risk management process, for its coordination and all its activities that go hand in hand with the project.

- The Risk Manager: He is the head of the risk management activities for a given project. He coordinates the activities with the project manager, monitors the risks and is responsible for transmitting information regarding risks to the project team and stakeholders. A risk management plan which is written down at the beginning of the project defines exactly his level of authority regarding decision making.

- The Risk Owner: Not every risk is similar. Therefore, some risks need risk owners with different skills than others. The risk owner has the expertise to treat the risk he is assigned to, in order to perform optimal risk responses, contingency plans, risk actions and monitoring the risk.

- Risk action owner or Risk response owner: Is the person responsible for carrying out the tasks included in his name.[17]

[15] Sherrer, J., 2010, P. 355
[16] OMV Austria, 2012, P. 3
[17] Sherrer, J., 2010, P. 355

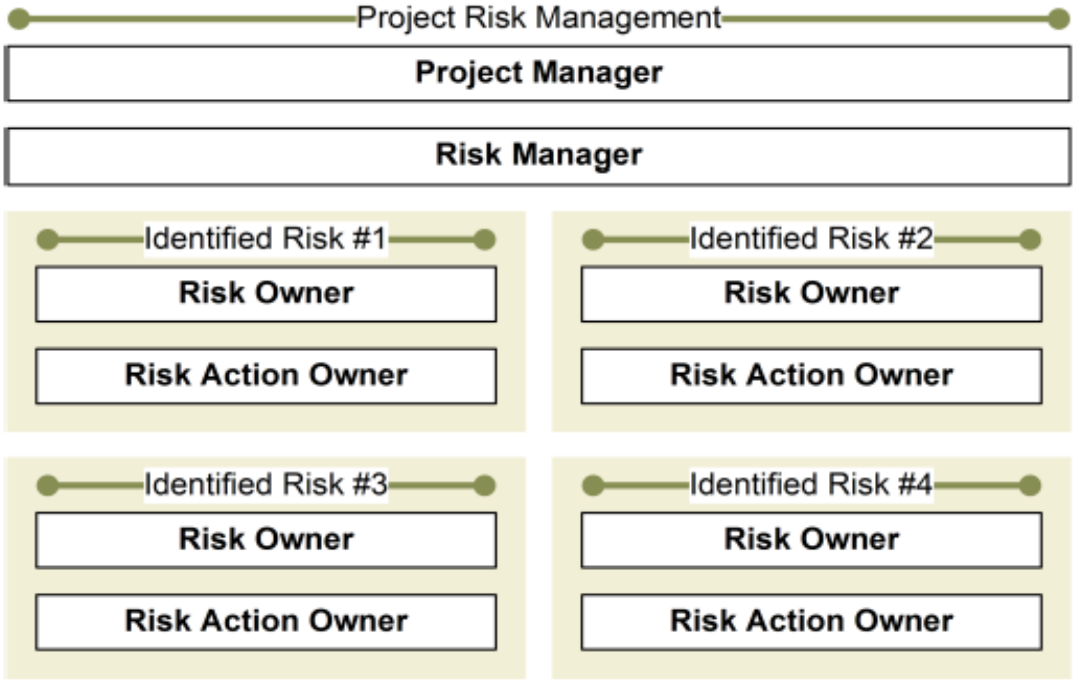

Figure 1: Roles in Risk Management[18]

According to several authors, the top management should be responsible for the management of risks. Responsibility in this case means to set the company's risk strategy and determining the direct responsibilities of each employee in the risk assessment.[19][20][21]

At OMV

The role distribution in risk management within **OMV** is quite similar to the theoretical approach. Hence, following roles must be assigned and resourced accordingly. Projects are recommended to include them (with clear deliverables, training requirements and time allocation) in the tasks and targets of all team members.

- Project Owner: Sets project objectives and risk acceptance criteria, approves risk management plan and risk matrix and uses risk information for decision making.
- Asset Development Manager: Own the project risk management plan, ensures risks appropriately reflect TECOP (Technical, Economical, Commercial, Organizational and Political factors) for the project, ensures risk management activities are executed effectively.
- Project Manager: Champions the risk management system, coordinates the risk management plan with the asset development manager approves risk responses and assigns resources for the risks, uses risk information for evaluating options and preparing decisions.

[18] Sherrer, J., 2010, P. 355
[19] Dickinson, G., 2001, P. 360-366
[20] The Faculty of Finance and Management of the Institute of Chartered Accountants, 2002, P. 1
[21] Federation of European Risk Management Associations, 2003, P. 1

- Risk Coordinator: Drafts the project risk management plan with the project manager, coordinates lessons learned from the past and up to date, gives training and support to risk owners and project team, maintains quality of risk register, proposes risk owners, accepts/rejects risks in risk register, reports to management.
- Risk Owner: Describes and assesses the risk and proposals suitable risk responses, obtains approvals and resources for responses, tracks progress, reviews risk, improves responses, closes risks.
- Action Owner: Executes actions as agreed with risk owner, records action status in risk register.
- Team Member: Identifies risks and proposes them to the risk register, gives feedback over effectiveness of risk responses to risk owner.

2.3 Risk Management Process

In Theory

Effective risk management is about finding a balance between probability and impact, as well as knowing how to detect, analyze and treat risks or opportunities. Understanding the risks as well as the strategy of the organization can be of crucial importance, as not every risk is worth dealing with, and not every opportunity may be have a big impact on the outcome of the project. Organizations must have a certain flexibility in order to act/react quickly whenever opportunities are identified that could be profitable. The tasks must be performed in a controlled form, within the parameters that have been pre-established.

Businesses are different; therefore each organization must assess a healthy mix in order to perform risk management on all levels. By doing so, the operations and projects will most likely achieve their full potential. The company will understand the risks and opportunities that it may encounter along the way. [22]

Risks need to be identified and treated, so that each activity can have a maximum value by increasing probabilities of success and decreasing probabilities of failures, without neglecting opportunities hidden in "positive" risks. Risk treatment means that an analysis process is then followed by an evaluation, resulting in a prioritization and decision by the responsible.

This continuous process of risk management runs and develops itself throughout the strategy of the company and its implementation. The culture and strategy of the organization integrate the entire process and therefore there is a translation from strategy into tactical and operational objectives.

Risk management processes:

- Provide the framework enabling future activities taking place in a controlled manner.
- Improve and support decision making, planning and prioritization. A good understanding of the activities and opportunities/threats are given.

[22] Ernst & Young, 2013, P. 3

- Help to use capital and resources in a more efficient way.
- Protect the image of the company
- Develop and support people and the organization's knowledge base
- Optimizes operational efficiency[23]

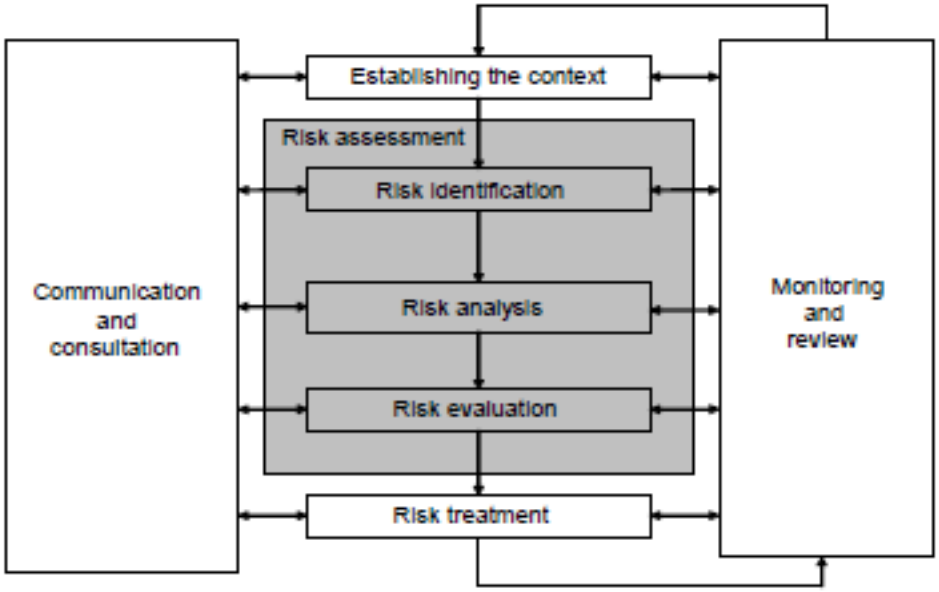

Figure 2: Risk Management Process by ISO 31010[24]

Figure 2 shows us an example of a standard of the risk management process given by ISO 31010 and ISO 31000.
Throughout the literature, we can determine a trend which breaks down the risk management process in four subareas:

- Identification of risks
- Quantification/evaluation of risks
- Management and control of risks
- Continued reporting on the development of risks[25]

At OMV

For **OMV**, it is of great importance that risk management is understood as a routine process, within all operations (ex: (Fahmisyafri, 2013) project management) and areas of knowledge.

OMV's approach can be seen as proactive through following activities:

[23] IRM, 2002, P. 4
[24] ISO 31010, 2009, P.13
[25] Henschel, T., 2008, P. 6

- Risk management must be performed on all capital projects, respecting the management commitment.
- The risk management process must be started early in the project lifecycle. Reason: Front End Loading

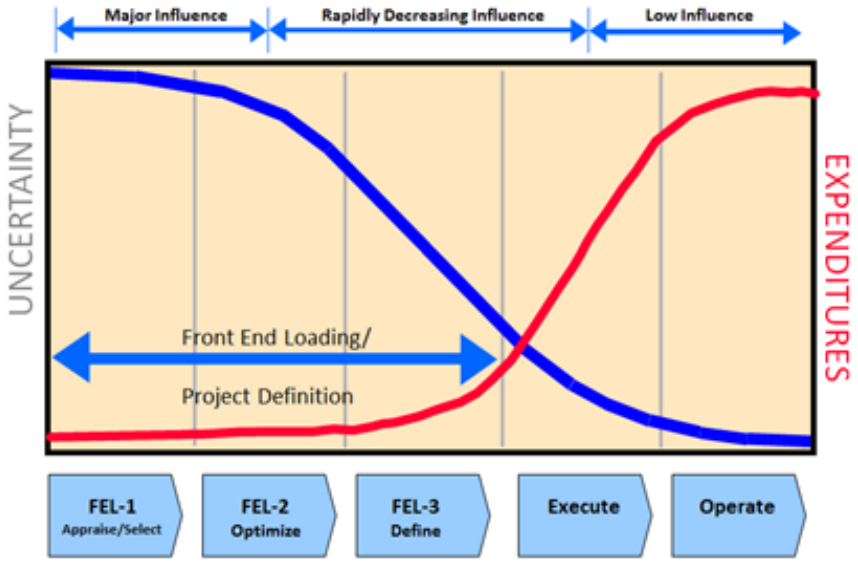

Figure 3: Front End Loading[26]

"The best opportunity to make a positive impact on the life cycle of a major capital project is during early planning, even before the capital outlay occurs."[27]

As figure 3 shows, the earlier we manage to identify and reduce the risk of a negative event, the less costly it will be for the organization, paired with a higher efficiency. All following risk processes and decisions are based on the risk register and have great impact on budget, timeframe and scope of the project.[28]

- Include all key stakeholders and disciplines in the process.
- Identification, assessment and prioritization of the key risks.
- Focus also on opportunities, not only on threats.
- Evaluation and updating project risks is continuous and regular task
- All changes, progresses and updates are communicated to the key stakeholders
- Lessons learned must be captured; project best practices must be shared.[29]

[26] Fahmisyafri, F., 2013, P. 1
[27] Ernst & Young, 2013, P. 1
[28] Operations Readiness & Assurance (OR&A) Ltd., P. 2
[29] OMV Austria, 2012, P. 4

Furthermore, the entire risk management policy is seen as being proactive. A proactive policy includes the anticipation of future changes or problems, while the reactive one would focus on responding to any situation. Being calculative would involve the assessment of probabilities for certain events.

2.3.1 Planning Risk Management – Establishing the Context

In Theory

Planning is the first step during a projects risk management phase. In this early stage, a plan is established with exact definitions.

The intensity of the risk planning is proportional to the priority, cost and complexity of the project. These key parameters are indicated in the project scope and project management plan. Specific risk management activities may also be required directly by the company, customer, stakeholders and project team.

Several standards such as the Project Management Institute Standard and the ISO 31000 Standard name this step differently, but it basically comprises the same facts.

The planning is commonly conducted by at least the project manager, project team and key stakeholders, but the best results are achieved by including a wider range of experts. At the end, a stable foundation should stand, offering a plan which can be seen as a guideline with several key points such as:

- Defining goals and objectives of the risk management activities.
- Defining the activity, process, function, project, product, service or asset in terms of time and location.
- Defining the relationships between a particular project, process or activity and other projects, processes or activities of the organization.
- Identifying, scoping or framing studies needed, their extent and objectives, and the resources required for such studies.[30]
- Risk management methodology: it describes the approach, tools and techniques which will be used. Furthermore, definitions are given and risk categories are predetermined.
- Risk responsibilities: roles and responsibilities of each individual in the team throughout the entire risk management process.
- Timeframe and budget for the risk management activities.
- Tolerances, thresholds and authority level: describing which risks can be tolerated up to which point, and describing decision making authority levels.[31]

[30] ISO 31000, 2009, P. 24
[31] Sherrer, J., 2010, P. 358

Risks must be classified in so called risk categories. Depending on the nature of the risk, it is classified in one of several categories. The sources can easily be identified and indicative guidelines can be set for each category.[32]

Category	Description	Indicative Guidelines (examples)
Financial	The inability to fulfill the commitments.	Missed business opportunities; Wrong estimate of labor cost or material cost;
Environmental	Nature related risks: energy efficiency, pollution, noise	Inefficient use of energy; Incorrect storage and waste treatment; sustainability issues
Technical	Quality of designs and materials, new technologies	Update to newest technology; lack of skills; quality of work

Table 2: Examples for Categories of Risks[33]

Further on, during risk evaluation, risks will have to be "prioritized" based on their probabilities of impact and the effects they may have on the entire project. A risk with an effect that may jeopardize the project and high probability is ranked as a high priority risk. This ranking is a scale, which is a clear, simple and easily understandable by all people involved in the risk management tasks.

Three types of scales are commonly used:

- The relative scale, which is the simplest one to use and to understand. The range is from very low to very high.

- The linear scale, a numeric scale ranging from the lowest number until the highest number in a linear way.

- The non-linear scale, which is a numeric but with unequal differences between the single numbers. Used for emphasizing an impact.[34]

At OMV

[32] District Council of Kent, 2012, P. 1
[33] Sherrer, J., 2010, P. 358
[34] Sherrer, J., 2010, P. 361

Generally, **OMV** standardized its own risk management plan, where the capital project is described, risk management scope and objectives are set and where the methodology is given. Furthermore, roles and responsibilities as well as levels of authorities and budgets are written down.

It is created by the Asset Development Manager, the Project Manager and the Risk Coordinator in the planning phase starting in "Identify & Assess", and is monitored and updated throughout the project lifecycle.

Figure 4: Project Risk Management Lifecycle at OMV[35]

The overall tasks are to define external, internal and the risk management context, as well as the classification of risk criteria.

The external context means that the company must get familiar with the surrounding in which the project will be located.

- Cultural, political, legal, regulatory, financial, economic and competitive factors whether international, national, regional or local.
- Key drivers and trends having impact on the objectives of the project
- Perceptions and values of external stakeholders

Internal context involves:

- Capabilities of the projects regarding resources and knowledge
- Information flows and decision-making processes
- Internal stakeholders
- Objectives and the strategies that are in place to achieve them
- Perceptions, values and culture

The context of the risk management process includes:

- Defining relationships between a particular project or activity and other projects or activities of the organization
- Defining risk assessment methodologies
- Defining risk criteria
- Defining how risk management performance is evaluated
- Identifying and specifying the decisions and actions that have to be made

[35] OMV Austria, 2012, P. 7

When defining risk criteria, focus has to be set on:

- Nature and types of consequences to be included and how they will be measured
- The way in which probabilities are to be expressed
- How a level of risk will be determined
- The criteria by which it will be decided when a risk needs treatment
- The criteria for deciding when a risk is acceptable and/or tolerable
- Whether and how combinations of risks will be taken into account

As an example, the following page shows the table of content of **OMV**'s standardized risk management plan.

Project Description

- Business objectives/project objectives
- Stakeholder analysis
- Project interfaces

Risk Management Scope and Objectives

- Success criteria / project trade-offs
- Exit criteria (economical & technical)
- Risk acceptance criteria

Risk Management Methodology

- Relationship with the organizational environment
- Risk management activities
- Project tailored risk breakdown structure
- Key deliverables
- Information sharing – lessons learned

Risk Management Organization

- Roles & responsibilities and levels of authority for risk management
- Budgeting for risk management activities added to the project budget

Use of Risk Management Tools

Communications Planning

Attachments

- Project Risk Breakdown Structure
- Project Risk Register
- Project Risk Matrix
- Project Risk Management Process Summary

Required Documents for Risk Workshops

Table 3: OMV Risk Management Plan – Table of contents[36]

2.3.2 Risk Identification

In Theory

Risks must first be identified before they can be processed. Therefore a risk register is developed as soon as the planning ends, with all threats and opportunities listed in.

This is an activity which is done in an early project phase; therefore all following processes are based on the identification of the threats and opportunities. The later they are identified, the more impact they may have on finances, timeframes and project scopes.

[36] OMV Austria, 2012, P. 2

Optimal identification of risks is achieved by gathering around all key people and experts such as project team, stakeholders, subject experts, consultants and other professionals, and having them collaborate.

Before going into details about methods and tools, it is important to discuss the sources of risks. Identification of risk is best started when key project documents and factors are first considered. These can be:

- The project scope baseline: It contains the project scope statement and the work breakdown structure. These documents define the project and can be used to find constraints and assumptions, which may result into risks.
- Activities: The list of activities and their attributes, estimations, costs may help for finding potential threats or opportunities.
- Project management plan: In this document, risk factors may be found in the scope, timeframe, budget, quality, human resources, procurement or technology.
- Enterprise environmental factors: Databases, benchmarks or studies which have to-do with the project may include risk factors. Furthermore risk elements such as culture, portfolio management practices, hierarchy or reporting structures may also be points of discussion.[37]

There are many methods of identifying risks. We can class them in three main categories: evidence based methods (checklists, historical data), systematic team approaches, and inductive reasoning techniques such as HAZOP (hazard and operability study)[38]. There is a large range of tools and methods classified into families for this purpose.

These are:

- Information gathering techniques:
    - Brainstorming: Consisting of a moderator, encouraging participants (a mix of diverse and experienced professionals) to let their imagination take over. A broad sight should be the focus and the participants are not interrupted during the brainstorming. The moderator throws in leading questions, which are used as starting point of the topic. The purpose of performing brainstorming is to stop blockages in the mind and enhance intuitive thoughts. It is a very simple, effective technique and is appreciated in many industries.[39] It is highly appreciated in the oil and gas industry, for example during the search of constraints and possible problems during redevelopment projects.[40]
    - Interviewing: Interviewing professionals and people with rich knowledge in the projects matter may be one of the easiest and most accurate methods. It can be done via e-mail, telephone or face to face and only requires that the interviewer is well prepared so that the right questions can be asked. Knowledge, experience and personal touch of the professionals are what make the interviewing technique very effective.

[37] Sherrer, J., 2010, P. 366-367
[38] ISO 31010, 2009, P. 14
[39] NyBlom, S. E., 2004, P. 3
[40] Wongnapapisan, B., 2004, P. 2

    - Surveys: Surveys can be useful for gathering risk information from experts in a structured way. They can be done anonymously and can be processed easily. Here also, the professionals performing the survey have a high level of experience and knowledge, and providing high quality results.
    - Root cause analysis: A method that helps identifying causes and problems that may be the root of an event.
- Documentation reviews: Here, the focus is on checking up incomplete, missing and old documents which are integrated in the project. Here, assumptions and limitations may be found, causing risks.
- Assumption analysis: This risk identification method consists of finding possible assumptions at any point in the project, being a source for risks. Reliability for every assumption is reviewed and may result in proof of inaccuracy of the assumption. In that case, there should be a proper project management process for replanning without any assumptions.
- Checklist analysis: Based on the risk categories and reviewed/improved throughout the project.
- SWOT analysis: A strategic planning tool which identifies Strengths, Weaknesses, Opportunities and Threats.
- Diagramming techniques:
    - Flowcharts: Steps and decision points are connected and pointed out. Risks may be found within relationships in the process.
    - Cause and effect diagram: Also called Ishikawa diagram, pointing out causes of specific events/problems.
    - Influence diagram: It is a graphical representation of a decision. Essential elements are displayed with decisions, uncertainties and objectives and how they influence each other. There is no sequential order.[41]

Once a risk has been identified, it is included in a so called "risk register", which is a list of all project risks with their information and updated throughout the project life. A risk register gathers a wide range of information such as:

[41] Sherrer, 2010, P. 371

Name	Detail
ID	Name of risk, ID number
Risk owner	responsible for monitoring & controlling
Risk category	Which family it belongs to (technical, environmental etc…)
Root cause	What is leading to the risk?
Potential response	How it might be treated
Impact	The effect the risk may have once it occurs
Probability	How likely will it occur
Risk score	Probability and impact score for the risk, usually the result of probability x impact
Risk priority	Which risk has priority over others
Risk response	The action taken once the risk has been evaluated. Exploiting opportunities and minimizing threats
Risk response responsibilities	Risk action owners
Secondary risks	Risk which arise through the response of a previous risk
Risk response budget	Budget/resources allocated for risk response
Risk response schedule	Timeframe for risk response
Contingency plan	Actions that will be taken if risk response fails
Fallback plan	Backup for contingency plan

Table 4: Information gathered in a risk register [42]

At OMV

OMV has a similar way of identifying risks. Early and regular identification are important so that key project decisions can be made at the right time, with an optimal strategy set in place. Also, risk identification should be possible at any time of the project risk management process and not be limited by any schedule or regulation. Furthermore, a broad range of risk sources is a guarantee for a higher possibility of identification. In this case, **OMV**

[42] Sherrer, 2010, P. 372

attaches importance to the term TECOP, which are risk sources standing for Technical, Economical, Commercial, Organizational and Political factors. A big focus is set on opportunities at **OMV** in order to maximize a projects value. Identified risks must be related toast least one projects objective and a wide range of stakeholders ensure that all perspectives are represented and considered. Furthermore risk statements must be complete, with a clear description and with an exact ownership.

Identifying risks is not a simple task, it requires the ability to look forward and therefore have a certain level of experience. **OMV** pairs a high level of expertise with three identification methods, which are also commonly used in the industry: the use of a risk breakdown structure, risk registers and brainstorming during risk workshops.

- Risk breakdown structures: Project risks are represented in a hierarchical manner, showing potential risk sources. An organized list of risks can be made with help of TECOP. Risks are then categorized and put in the risk breakdown structure at a point where they can be broken down once again. This risk identification method highlights the risk exposure types, dependencies between individual project risks, the root of a risk, correlations between risks and the overall project risk.
- Risk register: This is the document, where all risks are entered with a uniform format. This register is kept simple and manageable. Each individual risk gets an identification number, its source from the TECOP sources, and identification if it's a threat or an opportunity. Causes, the risk itself and its effect are described in a few words. Furthermore, we can find a quick yes/no answer if the risk is a potential show stopper. For risk identification, the risk register ends here, but continues as the next steps are risk analysis, evaluation and treatment. Therefore, the risk gets an individual rating and probability of occurrence resulting in a prioritization. A risk treatment plan with owner and contingency plan is developed. Figure 5 shows a conventional risk register

Risk Ref.ID	A unique reference number to easily identify each risk	
Project phase	Assess, Select, Define (FEED, Re-FEED, EPC, Operate, Demolition.	
Risk Description	A text description of the risks	
Key drivers	What might cause the risk to occur	
Existing controls	What's currently in place to manage each key driver?	
Assess Risk	Assess arrant risk severity. {impact & likelihood}. Risk score.	
Before Mitigation: Probability	Enter the Probability value 1-5, where :	
	5	Frequent, Almost Certain
	4	Probable, Likely
	3	Occasional, Moderate
	2	Remote,Unlikely
	1	Improbable, Rare
Before Mitigation: Severity,Impact	Enter the Severity, Impact value 1-5, where :-	
	5	Catastrophic
	4	Severe
	3	Critical
	2	Marginal
	1	Negligible
Before Mitigation: Priority	A traffic light value (Red, Amber, or Green) will be calculated automatically from the values entered against Probability & SeverityImpact	
Mitigation	What further actins (if deemed necessary) are planned to reduce the risk	
Action Owner	Who owns each of the further actions? The initials or full name of the business risk owner (select an individual rather than a team/group)	
Due date	When are the planned actions due to be implemented	
Resdual Risk	Assess arrant risk severity. {impact & likelihood}. Risk score.	
After Mitigation: Probability	Enter the Probability value 1-5, where :	
	5	Frequent, Almost Certain
	4	Probable, Likely
	3	Occasional, Moderate
	2	Remote,Unlikely
	1	Improbable, Rare
After Mitigation: Severity,Impact	Enter the Severity, Impact value 1-5, where :-	
	5	Catastrophic
	4	Severe
	3	Critical
	2	Marginal
	1	Negligible
After Mitigation: Risk Rank	A traffic light value (Red, Amber, or Green) will be calculated automatically from the values entered against Probability & Impact	

Figure 5: Detailed explanation of the components of a Risk Register[43]

- Risk workshops: A brainstorming with high cross-disciplinary expertise is led by a professional and strong facilitator. Risk workshops are strongly recommended for capital projects.[44]

2.3.3 Risk Analysis

This step is all about acquiring a better understanding of the risk. It provides an input to risk assessment and to decisions about whether risks need to be treated and about the most appropriate treatment strategies and methods. Here, the focus is on determining the impact and the likelihood of occurring in order to determine a level of risk.

[43] Bensahraoui, M., et al., 2012, P. 3
[44] OMV Austria, 2012, P. 8-9

The plan is to consider the causes and sources of risk, the probability and consequences and the factors that affect these facts. An event may have several consequences. Here, the methods used can be qualitative, semi-quantitative or quantitative.[45]

Qualitative risk analysis
In Theory

Qualitative risk analysis is the first of two tasks during risk analysis. It follows risk identification and leads to a prioritization of risks, because of the identification of many during the previous step. Here, two points are important.

- What is the magnitude, the impact of the event?
- How likely will the event occur?

The purpose here is to understand more about the identified risks and make priorities for the project. Project risks are described in words, probabilities and impacts during qualitative risk analysis.

The risk register shows the entire list of all identified risks. They are evaluated, prioritized and ranked based on their overall risk rating score, expected monetary value, impact, or combination of several methods.[46]

In the risk management plan, the methods of probability and impact assessments are established as well as the data sources. The overall main three steps during qualitative analysis are:

- Identifying risk sources, triggers and interdependencies
- Each project risk and opportunity receives probabilities and impacts
- Assessing and prioritizing by using a risk matrix

A risk matrix such as in the "Planning Risk Management" chapter gives a quick and simple overview over likelihood and impact (which is based on the project risk acceptance criteria of the risk owner) of each risk. These two main criteria are assessed by the project team which gathers and analyses data. It is important that approaches and risk terms are used which have been defined in the risk management plan. The result is a single risk severity which should not be understood as a quantitative result pointing out expected losses, costs or numerical values.

At OMV

The purpose of qualitative risk analysis is to provide a comprehensive understanding of known risks for prioritization on the project. Qualitative analysis is the attempt to adequately characterize project risks in words, in likelihood of occurrence, in impact on individual objectives and with the aim to develop appropriate risk treatment strategies. OMV suggests utilizing a risk matrix. It allows two measures: likelihood and impact.

OMV has following objectives when establishing a risk matrix:

- Maximizing the value regarding costs and benefits
- Respecting the schedules

[45] ISO 31010, 2009, P. 15
[46] Sherrer, J., 2010, P. 376

- Production targets (oil, gas, power, refined products)
- Ultimate recovery (E&P reserves)
- HSSE integration
- Community, government, reputation and media
- Legal and regulatory compliance[47]

OMV points out that it is important to stress that the results of the quantitative risk assessment (impact x likelihood) should not be understood as quantitative results. What differentiates qualitative risk assessment from quantitative risk assessment is that the former does not try to assign distinct numerical values to assets, expected losses, and cost of controls by using statistical modelling techniques. Instead, relative values are estimated in risk identification workshops.

Quantitative risk analysis
In Theory

Costs or other impact measurements are assigned to identify risks when performing quantitative risk analysis. A numerical estimate of the overall risk effect is performed. This step takes place on an individual risk level where estimates of the projects objectives such as scope, budget and schedule are made. This is a continuous step which is performed frequently during risk monitoring and control in order to see if the project's overall risk level has changed. It is a time and budget consuming task and therefore should only be done on high priority risks. The goals for performing quantitative risk analysis are: predicting likely project outcomes based on combined risk effects, characterize the risks likelihood and impact by using probability distributions, to use project models, to estimate likelihood of meeting targets and contingency requirements and to identify risks with the ´greatest effect on the overall project risk.[48]

As for each task, the risk management plan defines the methods and responsibilities for quantitative risk analysis. The results are transmitted into the risk register, which is therefore updated on a regular basis.

Some of the methods to perform quantitative risk analysis are:

- Sensitivity analysis: Each project objective is considered individually, and how uncertainty can change the impact. Hence, it is possible to identify which risks have bigger impacts then others. Sensitivity analysis is particularly useful, when considering projects within field development decisions or exploration decision making. The principle starts from a "base case" analysis which should contain the central or most probable assumptions. We change one assumption at a time, keeping all other assumptions the same as in the base case.

[47] OMV Austria, 2012, P. 10
[48] OMV Austria, 2012, P. 10

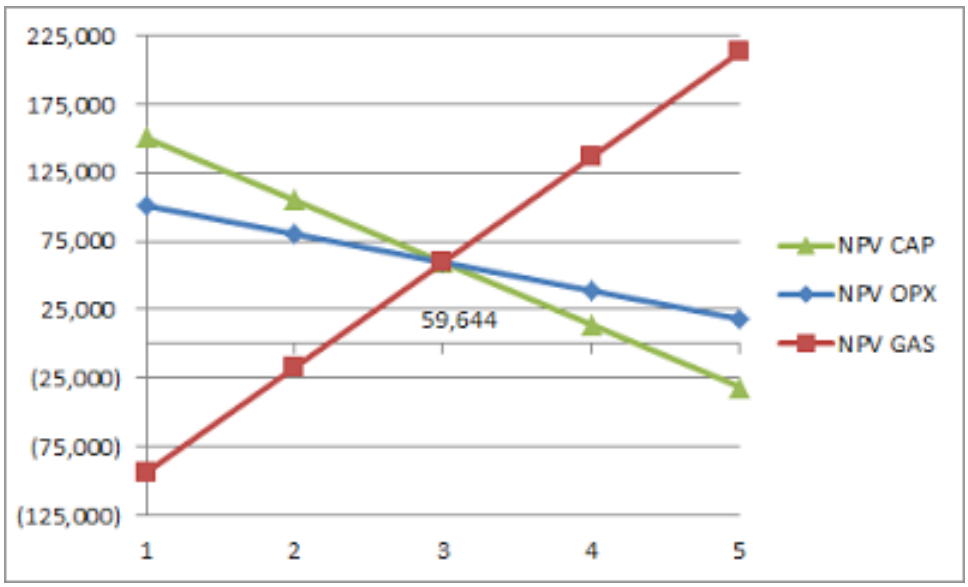

Figure 6: Sensitivity analysis using a spider diagram[49]

It shows that the steeper the "legs" of the spider, the more sensitive is the project to changes in that variable. As we can see in the figure above, offshore projects are typically most sensitive to variations in capital costs (front end costs) and oil prices (determine revenue of the project), and not so sensitive to operating costs (they occur later in the project, and are small in relation to other costs).[50]

- Simulations and modeling techniques: Simulations and modeling are complex, statistical and computer-driven tools. The Monte Carlo Simulation is a common simulation tool which is used in many sectors like insurance, engineering and finance.[51] It is a method for iterative simulation for modeling significant uncertainties in inputs, then the probability distributions of outputs show which value is most likely. Usual simulations run from 1000 to 10000 trials. This technique is especially used for decision making when the decision makers have the choice between several options. The Monte Carlo Technique does not require a professional risk analyst or computer modeling expert and can be used easily by using software like @Risk. The total project cost is summed by costs of all activities and corrected by risk factors. The total duration of the project is the sum of all the time spent in every activity, while considering time overlapping. All the inputs should be converted to monetary values (for example: how much the cost will be if the equipment is delivered three weeks later.)[52]
- Expected Monetary Value: With this method, the cost or benefit of an uncertain event is calculated by multiplying Monetary Impact by Probability. EMV shows the expectation one could have if the situation is repeated many times.

[49] Asmoro, T.H., 2012, P. 2
[50] Allinson, G., 2008, P. 1
[51] Macmillan, F., 2000, P. 17
[52] Gu, M., 2012, P. 1

- Decision Tree Analysis: This method is used to point out different options with different scenarios and EMV's. Therefore, each decision path receives a net value. This method can be used for many project problems showing monetary impacts. [53]

It is important to say that that the level of risk will depend on the adequacy and effectiveness of existing controls. The questions may be:

- What are the existing controls for a particular risk?
- Are those controls capable of adequately treating the risk so that it is controlled to tolerable level?
- Are the controls operating in the manner intended and can they be demonstrated to be effective when required?[54]

At OMV

OMV's view over quantitative risk analysis is about providing a numerical estimate of the overall risk effect on the project's objectives, by considering risks and their correlations simultaneously.
Therefore several purposes are listed:

- To predict likely project outcomes based on combined risk effects
- To characterize the risk's likelihood and impact by using probability distributions
- To use project models (schedules, cost estimate models)
- To estimate likelihood of meeting targets and contingency requirements
- To identify risks with the greatest effect on the overall project risk[55]

The most common used tools are Monte Carlo simulations and Decision Tree Analysis. Nevertheless, the user may use any other relevant technique, depending on the availability of the project data as well as the user's knowledge.

2.3.4 Risk Evaluation

In Theory

During risk evaluation, we compare estimated levels of risk with risk criteria defined during the context was established, so that the significance of the level and type of risk can be determined.

Risk evaluation requires the understanding of risk obtained during risk analysis for the decision making of future actions. Here, ethical, legal, financial and other considerations play a role. The decisions may include:

- Whether a risk needs treatment
- Priorities for treatment

[53] Sherrer, J., 2010, P. 381-385
[54] ISO 31010, 2009, P. 15
[55] OMV Austria, 2012, P. 9

- Whether an activity should be undertaken
- Which of a number of paths should be followed

The easiest framework for defining risk criteria is a single level which divides risks that need treatment from those which do not. Hence, the result is a simple result but it does not reflect the uncertainties involved in estimating risks and in defining the boundary between those that need treatment and those that do not.

The decision about whether and how to treat the risk may depend on the costs and benefits of taking the risk and the costs and benefits of implementing improved controls.

Here, a common approach is to divide risks into three bands:

- An upper band: the level of risk is regarded as intolerable whatever benefits the activity may bring, risk treatment is essential whatever it costs
- A middle band: costs and benefits are taken into account and opportunities rebalanced against potential consequences
- A lower band: the level of risk is regarded as negligible

The "as low as reasonably practicable" or well-known as ALARP criteria system used in safety applications follows this approach.[56]

At OMV

Risk evaluation should be assistance to the Asset Development Manager and Project Manager in decision making. The decisions are based on the outcomes of risk analysis, which risks need treatment and their priority. Focus is set on comparing the level of risk found during the qualitative and quantitative analysis with risk acceptance criteria established when the risk management plan was decided. Legal and regulatory requirements should be respected as well as costs and benefits.[57] The approach is similar to the theoretical approach mentioned above.

2.3.5 Plan Risk Responses – Risk Treatment

In Theory

This chapter describes how risks are treated and the actions that need to be taken, since we have already discussed the previous steps of identifying, analysing and prioritizing the risks. The goal of responding to a risk is on the one hand to reduce the threat and impact of a negative risk and on the other hand to enhance opportunities and impact for risks of positive nature. Also a "plan B" needs to be established.

This is a process which is performed after a risk has been prioritized and which is mostly conducted on the highest priority risks. If a new high priority risk appears throughout the project, then this process takes place again and is therefore a continuous process.

When we discuss about a risk response and its planning, three different types of risk actions are meant:

- A conventional risk response: Here, probability and impact of a risk is being influenced before occurrence. Negative risks are eliminated, or their impact is reduced if

[56] ISO 31010, 2009, P.18
[57] OMV Austria, 2012 P. 10

they occur. The response of a positive risk is to increase its probability of occurrence or increase its impact.

- A contingency plan: This risk action takes place once the risk has occurred, and therefore the following activities are determined. Here, the focus is on influencing the impact of the risk in both cases negatively or positively. Regardless of the previous risk response, it is a must to have a contingency plan since one action treats before and one action after occurrence.
- A fall-back plan: This sort of "plan B" is put in place in case the contingency plan fails. Here, a sort of recovery takes place and defines exact steps and in which exact situations and circumstances it is activated or deactivated[58]

There can be several response options for risks, differing in advantages and disadvantages. Choosing the most effective option needs a careful and precise analysis of every option. Once the response has been performed, it is possible that a secondary risk arises, which has not existed previously. It may even have a greater impact than the previous treated risk. A residual risk is a risk that remains once the response has been done, and where probability and impact are in the tolerance zone of the company. This so called risk tolerance is noted in the risk management plan and is usually anchored in the philosophy of the company. The cyclical process therefore comprises the assessment of a risk treatment, the decision whether the residual risk is tolerable. If not tolerable, new risk treatment is generated followed by an assessment if the new treatment has been effective.[59]

There are several risk response strategies, and it takes a combination of responses to influence risks. These risk responses are decided in advance, before the risk has even occurred in order to influence its probability and potential impact if it occurs. The risk response strategies are:

- In case of Threats: Avoid, Mitigate, Transfer
- In case of Opportunities: Exploit, Enhance, Share
- Either: Accept, Contingent[60]

The definitions are:

- Avoid: Eliminate a risks probability or impact to zero. Can be executed by restructuring the projects activities, scope, schedule or cost.
- Mitigate: If the risk is unavoidable, the main focus is to reduce the risks probability or its impact if it occurs.
- Transfer: Here, the risk is partly or totally assigned to a third party through outsourcing, contracts, insurance, warranties, guarantees or performance clauses. Here, the risks probability or impact may not change, but the responsibility does to lie anymore within the company.
- Exploit: Here, the focus is to push the risk to definitely occur, with all its benefits.

[58] Sherrer, J., 2010, P. 392
[59] ISO 31000, 2009, P. 27
[60] Sherrer, J., 2010, P. 394

- Enhance: If no action can be taken to guarantee the occurrence of the opportunity, then the response is to enhance its probability or its impact of occurrence.
- Share: Here, the aim is to share the opportunity with a third party who is best able to capitalize on it.
- Accept: Can be for positive and negative risks, where almost nothing can be done in case of low probability and low impact.
- Contingent: Involves a contingency plan, and is used whenever the risk response fails. The contingent response identifies the triggers in which the contingency plan can be put into effect and when it can be discontinued.[61]

At OMV

We can notice that the approach used within **OMV** is identical to the approach explained in the theoretical part above, offered by the Project Management Institute Standard. Furthermore, we notice that the risk management standard at **OMV** is generally based on the ISO 31000 Standard with small influences from the PMI Standard.

2.3.6 Risk Monitoring and Review

In Theory

Risks occurring in a project never remain static once the risk planning processes are completed. Here many actions influence the risks, new risks occur, responses do not work as planned. This phase in risk management starts as soon as risk planning begins and continues until the closure of the project. The activities during this phase are:

- Identifying new risks
- Analysing identified risks for changes in likelihood and impact
- Determining the need to execute contingency or fall-back plans
- Reviewing risk response actions and their efficiency for new upcoming risks, and implementing fall-back plans when needed
- Always having an eye on the risk watch list
- Monitoring residual risks
- Reviewing for any assumptions that may be false
- Ensuring the following of the risk management plan and risk management policies
- Analysing risk data, identifying trends and producing risk reports
- Ensuring that appropriate documentations are maintained, including lessons learned

[61] Sherrer, J., 2010, P. 395

- Instigating recommended changes and preventive or corrective actions as a response to results uncovered from risk monitoring and control.[62]

At OMV

This step is defined as being a systematic, continuous tracking and assessing of already identified risks, residual risks, and new risks discovered during the project lifecycle. The purposes of performing risk monitoring and reviewing are:

- Ensure that controls are effective and efficient
- Obtain further information to improve risk assessment
- Analyse and implement lessons learned
- Identify emerging risks
- Detect changes in the external and internal context, including changes to risk acceptance criteria and the risks themselves, which can require revision of risk treatment and priorities[63]

Therefore, risk treatment plans provide a performance measure. The results are incorporated internally in various reporting media which reaches different targets, such as:

- In the projects risk register and risk matrix
- In the monthly and quarterly project reports
- In the regularly updated risk management plan

The risk treatment plan is built around how to plan to respond to potential risks. It describes the management of high, low or acceptable risks and identifies how to avoid, transfer, mitigate and accept risk.

Nevertheless, the Asset Development Manager and Project Manager must regularly have risk review meeting with the team and stakeholders. The results then should be documented and analysed in risk reports. Therefore, the size, complexity and duration of the project play a role.[64]

2.4 Selection of Risk Assessment Techniques

Risk assessment can be conducted in several degrees of intensity by either using one or several methods ranging from simple to complex, depending on the depth and detail we wish to achieve. The desired depth and detail will usually be defined in the risk management plan.

In general, risk assessment techniques must have following characteristics:

- They must be appropriate to the situation.
- Results should be provided which can enhance the comprehending of the risks nature, as well as how it can be treated.

[62] Sherrer, J., 2010, P. 398
[63] OMV Austria, 2012 P. 10
[64] OMV Austria, 2012 P. 10

- It should be capable of use in a manner that is traceable, repeatable and verifiable.[65]

The choice of techniques is always in regard to the relevance and suitability, and the integration of results from different studies should be based on similar techniques. Once the performance of risk assessment has been decided with corresponding scope and objectives, the techniques must be selected based on following factors:

- The objectives of the risk assessment will have direct bearing on the techniques used.
- The needs of decision makers such as a high level of detail.
- The type and range of risks being analysed.
- The decision on the depth to which risk assessment is carried out should reflect the initial perception of consequences.
- The degree of expertise, human and other resources needed.
- The availability of data and information. Some techniques need more information and data than others.
- The need for a modification or an update of the risk assessment.
- Any regulatory and contractual requirements.[66]

Therefore, it is also important to mention that there are limitations which may affect the choice of risk assessment techniques such as the level of experience of the risk assessment team. Furthermore, time and budget play a decisive role in the decision making.

Risk assessment techniques can be classified in various ways to assist with understanding their relative strengths and weaknesses.

A big amount of techniques apply to each step of the risk assessment processes, which are:

- Risk identification
- Risk analysis – consequence analysis
- Risk analysis – qualitative, semi-quantitative or quantitative probability estimation
- Risk analysis – assessing the effectiveness of any existing controls
- Risk analysis – estimation the level of risk
- Risk evaluation[67]

[65] ISO 31010, 2009, P. 18
[66] ISO 31010, 2009, P. 20
[67] ISO 31010, 2009, P. 23

2.5 Key Findings in the Literature

There is a great amount of literature regarding risk management, mainly for concerns. The findings regarding risk identification, risk evaluation, risk monitoring and risk reporting offer a solid base for the following survey of this thesis. We notice a common understanding, there should be avoidance in elaborate methods (e.g. the probabilities of occurrence) when performing the task of risk identification and evaluation. The focus should instead be set on checklists, questionnaires, workshops, mind maps, feedback diagrams and risk brainstorming.[68][69][70] These methods do not require great expertise and are easy to handle. With these methods, the use of expensive software and the training of the ones using it are not needed; therefore resources may be saved and can be allocated elsewhere.

We can find difficulties in the structuring of strategic risks. Therefore, workshops should be implemented in order to identify these risks. A proposed workflow might be to first approach the theme by brainstorming or mind maps. Like that, larger risk areas should be derived, to then be analysed by more detailed identification procedures. Mind maps enable the bringing out the landscape of a company and to graphically document the mutual dependencies between the respective risk areas. The detailed reflection helps breaking down the risk areas, aiming for suitable indicators so that individual risks can be monitored.[71]

It has been empirically revealed that smaller companies employ less formal procedures for risk identification and evaluation then larger companies.[72][73] Managers in charge have great dependency on their own experience and attempt to gather knowledge on their risk situation through discussions with colleagues and experts[74]. Furthermore, in Europe, the frequency of risk reviews is more or less at the same level. Over half of all companies check their risks at least twice per year.[75] All in all, the entire process of risk assessment in the SME's is not implemented very systematically.

It is only possible to take appropriate measures in good time when the management receives regular information on opportunities and risks. It is recommended that risk management must be linked to the robust process of standard reporting. Risk reporting should take place once a month in the frame of the standard reporting. Reviewing the countermeasures specified for the identified risks should be made every three months.[76] The topic of risk reporting is very important and that there isn't a great amount of empirical findings in recent times. There are no important findings about how the board of directors is informed about risky developments. With the survey in this thesis, we will try to answer the question about how top management is linked with risk management, and in what extent the results influence decision making.

Another issue which will be an important topic for the thesis will be the risk strategy. As from the literature, big companies are more likely in having an official risk strategy.[77] Big companies or concerns usually possess good risk strategy handling; nevertheless it will be an important topic for the survey to see how E&P companies position themselves.

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[68] Auckenthaler, C., Gabathuler, J., 1997, P. 26-30
[69] Baisch, F., et al., 1998, P. 236-243
[70] Hahn, K., et al., 2000, P. 2620-2628
[71] Henschel, T., 2008, P. 52
[72] Kessler, B., 2000, P. 4 -15
[73] Helliar, C., et al., 2001, P. 8
[74] Henschel, T., 2008, P. 52
[75] Turpin, M., 2002
[76] Klatt, M., et al., 2005, P. 67-72
[77] Turpin, M., 2002

Another important aspect is risk management documentation. It is a significant issue so that employees have a guideline on how the risk management is to be implemented and new employees can be informed about it. The documentation should include:

- The definition of the risk strategy
- The measures for managing risk
- Risk reporting cycle
- It must furthermore cover rules on emergency situations and on representation[78]

It is proven that in some cases, as part of the rating process the bank will also evaluate the implementation and documentation of the risk management. A poorly documented risk management may therefore lead to a worsening of the credit conditions.[79] Therefore, in order to assess the efficiency of risk management within the E&P industry, it will be important to identify the trend and methods of documentation by means of a survey.

Regarding project risk management, we find in the literature that there are a few critical success factors, such as:

- Clear goals and objectives
- Support from senior management
- Adequate funds and resources[80]

The risk management process in project-orientated enterprises should make use of both top-down and bottom-up approaches, in defining risk policy and in risk analysis. Risk management should be part of a comprehensive management system, dealing with the entire enterprise as well as with each single project. The top management has the overall view and can define the risk strategies and thresholds of risk figures (top-down). Conversely, information of the single projects must be fed back to the top from those closest to the sources of risk (bottom-up).

This is why an integrated risk management demands a risk policy for single projects to be structured "top-down" and "bottom-up". Single projects must be considered with respect to the risk situation of the entire organisation, not as isolated developments. Consequently, there is a need to guarantee that control measures for the entire organisation are completely compatible with those related to single projects, and that they are integrated into the entire control system.[81][82]

2.6 Case Studies

In this chapter, we will see how companies perform risk management and what importance they give to this process in order to assess the main differences from capital projects within **OMV**. For this purpose, we will review some randomly chosen case studies, but where a clear documentation of the risk management process has taken place. But first, it is necessary to gain a better insight about the use of risk management standards in Austria and Germany based on a study from Ass. Prof. Dr. Mont. Schröder (Department of Econom-

[78] Henschel, T., 2008, P. 58
[79] Wildemann, H., 2005, P. 233-241
[80] Henschel, T., 2008, P. 60
[81] Guserl, R., 1999, P. 426-429
[82] Henschel, T., 2008, P. 62

ics and Business Management, Montanuniversität Leoben). For this, we will have a closer look at the survey conducted by Schröder in order to gain a better understanding over the methods used in risk management.

As mentioned earlier (Chapter 2.1.2), over 100 different regulations and standards exist for the topic of risk and risk management. Fact is, business environments change constantly and therefore also laws, policies and standards change unavoidably.

The study has been conducted where preferred methods have been identified throughout the individual processes. Here we must say that the easier the tool can be handled, the more likely it will be used. Therefore, brainstorming enjoys great popularity since it is easy to conduct and very effective and method 635 is used the least within the industry.

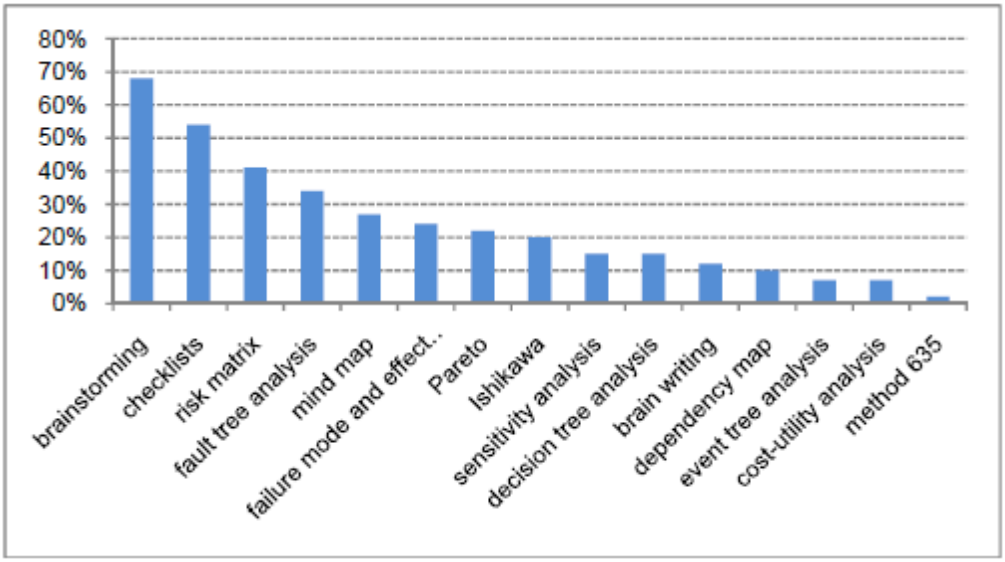

Figure 7: Ranking of preferred risk management methods[83]

The use of methods during different steps within the risk management process is summarized, with following results:

- **Risk Identification**: Brainstorming, Checklists, Fault Tree Analysis, Mind Map, Failure Mode and Effect Analysis, Ishikawa, Brain writing, Method 635
- **Risk Analysis and Assessment**: Risk Matrix, Failure Mode and Effect Analysis, Pareto, Ishikawa, Sensitivity Analysis, Dependency Map, Event Tree Analysis, Cost-Utility Analysis
- **Risk Control**: Checklists, Risk Matrix, Fault Tree Analysis, Failure Mode and Effect Analysis, Decision Tree Analysis, Event Tree Analysis
- **Risk Monitoring**: Checklists, Risk Matrix, Failure Mode and Effect Analysis, Cost-Utility Analysis

We notice that the Failure Mode and Effect Analysis tool is used in all risk management steps, and tools like Decision Tree Analysis or Method 635 (6 people generate each three ideas every five minutes during half an hour) are only useful in one step of the entire pro-

[83] Schröder, W., 2013, P.8

cess.[84] Furthermore, we can see similarities within the general application of risk management techniques from figure 7.

There is a great number of other studies which have been performed to identify the behavior of companies regarding risk management. A study by the University of Applied Sciences in Würzburg, where 114 companies of no specified industry have participated, has given following results:

- 33% of the companies perform risk management regardless of the size of the project. The rest of the companies link their risk management activity to the size of the project.
- Financial risks have the biggest importance (43%), followed by time related risks (23%) and then from technical risks (13%). Other, but less important risk categories are HSEQ, contractual and political risks.
- Risk identification is performed with the help of checklists for 76% of the participants. Brainstorming (53%) as well as performance indicators (47%) are also well used, and show that many companies prefer to combine two methods than to depend on one.
- Problems which have been revealed byte companies are mainly due to three factors: time consumption (35%), complexity (34%) and the inaccuracy of results (31%).
- The preferred tools for risk analysis are mainly the Cost-Utility analysis (53%) and Risk Maps (33%), due to their easiness of usage. Furthermore, costs play a role as well as time consumption.
- 55% of the participants try to reduce the impact of risks while considering the calculation for the project. When it comes to risk prevention, 51% of the participants would try to remove the risk, even if there are chances that the project is not successful.
- 89% of the questioned companies monitor their risks, once they have been treated. The frequencies are different, but a tendency can be observed, such as monitoring every time a milestone has been reached (54%). 16% monitor their risks on a twice a month basis, 9% once a month, 7% every week, 4% every 2 months and 2 % every 3 months.

Schröders key findings regarding which methods are used for the corresponding give a global idea which risk management tasks are performed in German countries. Nevertheless, we wish to perform a survey within the E&P industry in order to see what are the differences, or similarities.

Case Study Drilling Project

As a first example regarding E&P, we will look at the risk management workflow within ENI, especially during a well campaign offshore in China. Here, a project risk is defined as "an uncertain event or condition that, if it occurs, has a positive or negative effect on at least one project objective. A risk may have one or more causes and, if it occurs, one or more impacts".[85] This definition is taken from the "Guide to the Project Risk Management Body of Knowledge" (PMBOK Guide) from PMI (Project Management Institute). Objectives such as HSE and schedule, CAPEX, OPEX, revenues and corporate relations with

[84] Schröder, W., 2013, P.9
[85] Zausa, F., 2011, P. 2

third parties are of main importance. Eni uses an implemented risk management system named "AWARE", which is used on drilling and completion projects. "AWARE" stands for **A**dvised **W**orkflow for **A**ccurate **R**isk **E**stimates, and has following workflow:

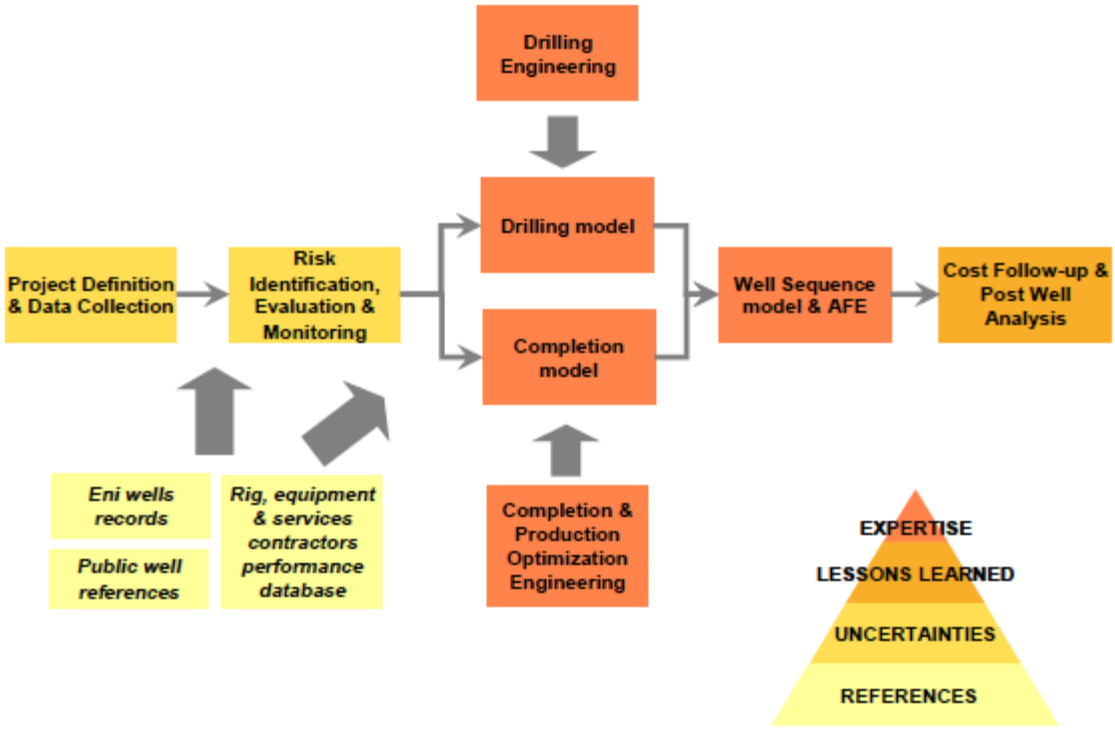

Figure 8: Risk Management Workflow[86]

As we can see in Figure 8, Eni makes use of databases where well records, probabilistic applications, risk registers etc. are stored and can be used for projects similar to the reference project. This eases the identification of risks and the definition of probabilistic variables. Uncertainties definition and monitoring is put together in a risk register and qualitative risk analysis is done through matrixes. Emphasis is placed on experience, expertise and best practise, which are present at every step of the process, and especially for building the probabilistic model. Figure 9 shows a more detailed workflow of the AWARE system of Figure 8.

[86] Zausa, F., 2011, P. 4

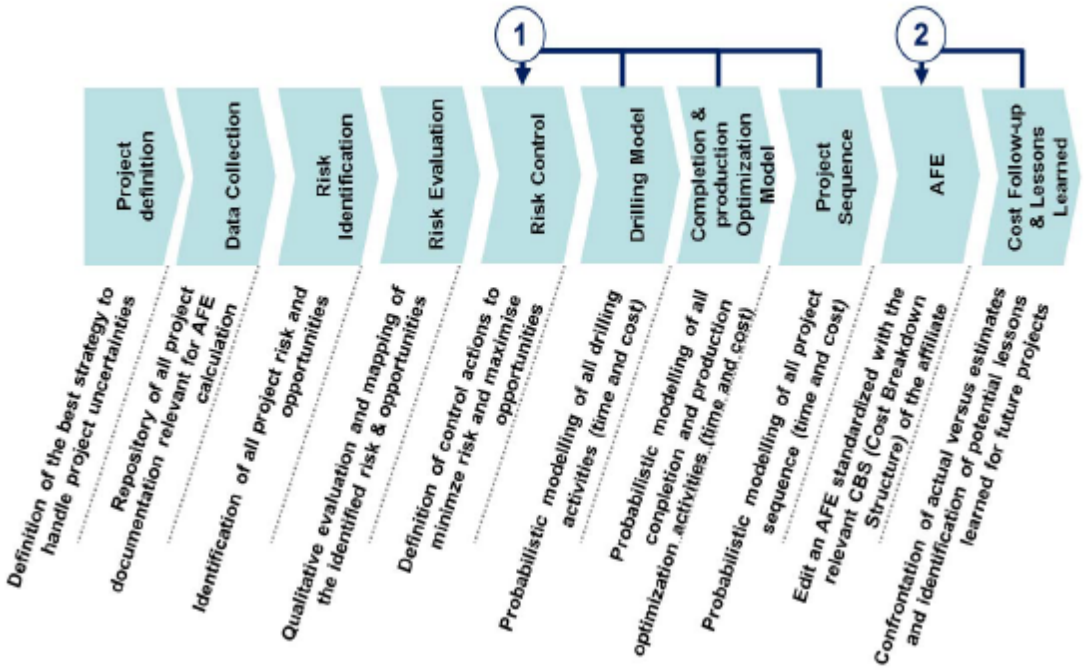

Figure 9: Ten steps of the AWARE system[87]

Regarding data collection, three existing and comparable wells have already been drilled, delivering reliable data for risk identification and evaluation. In this case study, 14 risks have been identified with three sources:

- Offset well analysis
- Experts interviews
- Risk check list

During qualitative analysis, risks are prioritized and ranked. Here, conventional Low, Medium and High ranking systems were used regarding the probability and impact of the event. At the step of risk control, once the risks have been identified and evaluated, five different actions have been proposed in order to mitigate risk issues. Finally, during the evaluation of the drilling model, the probabilities of all individual risks are combined with drilling time and cost sequence. Here, the five different actions are combined in 4 different scenarios, and a Monte Carlo Simulation was run with cost/benefit impact of the scenarios giving following result:

[87] Zausa, F., 2011, P. 5

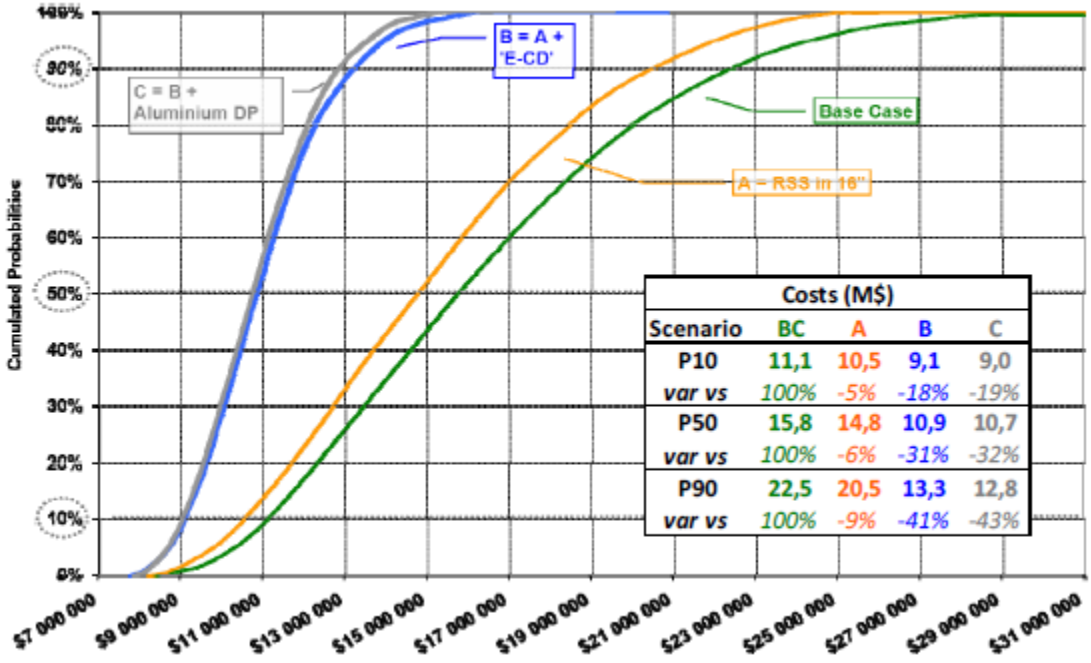

Figure 10: Scenarios Cumulated Probabilities[88]

In this case study, the scenario with the lowest cost at P50 was chosen (in this case in grey)[89], and turned out to be very accurate to what really happened.

At the end of the project, the risk management database was updated in order to give feedback for future projects.

Case Study Marine Project

Next example will come from a standard used within Abu Dhabi Marine Operating Co., which counts big players in the Gulf region such as BP, TOTAL and ADNOC as shareholders.

Key steps to their risk management approach are:

- Risk Assessment utilizing HAZID register
- Risk Reduction / Minimization / Containment
- Risk Monitoring
- Quantitative Analysis
- Opportunity/Threat Analyst
- Risk Reporting
- Risk Evaluation[90]

[88] Zausa, F., 2011, P. 10
[89] Zausa, F., 2011, P. 10
[90] Al Jesmi, B., 2012, P. 2

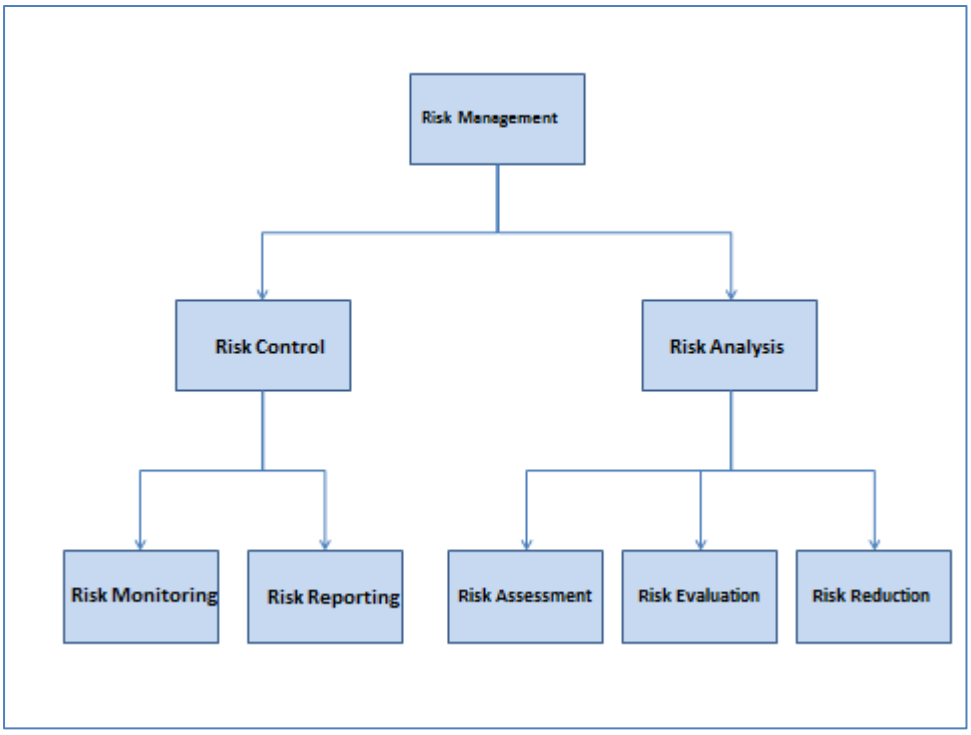

Figure 11: Risk Management Breakdown Structure[91]

The severity of the potential hazard to People, Assets, Environment and Reputation (P.E.A.R.) is the decision criteria for risks identification and categorization. Short and long term measures are taken in order to eliminate or prevent occurrence of hazards, or to reduce the risk level to be As Low as Reasonably Practicable (ALARP). Risk is defined as "the chance or possibility of loss, damage, injury or failure to achieve objectives caused by an unwanted or uncertain action or event. Risk management is the planned & systematic approach to the identification, evaluation & control of risk. The objective is to secure the assets & reputation of the organization and to ensure the continued financial and organizational wellbeing."[92] By breaking down the objectives, seven reference points can be highlighted:

- To ensure that risk management is a clear and consistent process and integrated in the culture of the company.
- Best practices will define the management of risks.
- Anticipation and responding to social, environmental and legislative requirements
- Existence of a minimum standard regarding health, safety, insurance and legal requirements
- Prevent death, injury, damage, losses as well as reducing the cost of risk
- Identify risks and their impact in order to inform policy and operational decisions
- Raise awareness of the need for risk management[93]

[91] Al Jesmi, B., 2012, P. 2
[92] Bensahraoui, M., et al., 2012, P. 2
[93] Bensahraoui, M., et al., 2012, P. 2

Identifying risk categories is the first step in this process. Here, the focus lays on impact of costs, timescales, quality, maintainability or usability of products. The techniques are:

- Brainstorming
- Risk Prompt Checklist
- Review lessons: similar projects or workstreams in the past are reviewed in order to determine uncertainties as well as risks and opportunities.
- Project & Schedules: Have all approval target dates been met? Is any project falling behind schedule?
- Project finances: What is the tolerance and how is the project running regarding budget?

After entering all important data into the risk register such as the reference number, name, project phase, owner etc., the risk matrix is developed with a conventional impact vs. likelihood grid. Here, questions rating the probability can be "Has it occurred in worldwide industry but not in Group Company" for the least probable event to "Happens several times per year in same location or operation" for the most frequent. Also, a semi-quantitative approach is incorporated for occurrence from 1 in 100 000 years to 1 in 10 years.

			Likelihood , Probability, Frequency				
			A	B	C	D	E
		Qualitative	Has occurred in Worldwide Industry but not in Group Company	Has occurred in other Group Company	Has occurred in Company Specific Group Company	Happens Several times per year in specific Group company	Happens Several times per year in same location or operation
		Semi-Quantitative	Improbable	Remote	Occasional	Probable	Frequent
			1 in 100,000 years	1 in 10,000 years	1 in 1,000 years	1 in 100 years	1 in 10 years
Consequence, Severity	5	Catastrophic	5	10	15	20	25
	4	Severe	4	8	12	16	20
	3	Critical	3	6	9	12	15
	2	Marginal	2	4	6	8	10
	1	Negligible	1	2	3	4	5

Table 5: Scoring Guidance for Risk Matrix[94]

Identified risks need to be subjected to an analysis and evaluation so that probability as well as consequences can be assessed. Therefore, the first step is to determine the likelihood that the combination of threats result in occurring events, followed by the determination of the chances that an incident can develop into an accident with consequences. This determination is based on professional judgement, experience and historical data within the company.

Table 6 shows a risk register template used at Abu Dhabi Marine Operating Co.

[94] Bensahraoui, M., et al., 2012, P. 2

dentifying risks to our business					Identifying what mitigation is currently in place	Assessing current risk severity						Assessing residual risk severity		
Ref	Ref	Phase	Risk / Opportunity	Key Drivers	Existing Controls / Processes	Current		Risk Score	Mitigation Actions	Action Owner	Due Date	Residual		Risk Score
Risk Ref	Rank	RE-FEED / EPC	Describe the risk?	What might cause the risk to occur?	What is currently in place to manage each key driver?	Impact	Likelihood	Current risk ranking	What further actions (if deemed necessary) are planned to reduce risk	Who owns each of the further actions?	When are the planned actions due to be implemented?	Impact	Likelihood	Residual risk ranking
9	4	RE-FEED	Delay of RE-FEED completion & rework	Lack of information on contemporary interfacing projects	1. Interface meetings with related personnel in projects & Operations to address areas of concern 2. Lessons Learnt 3. Early involvement of relevant personnel in scope of work preparation	4	C	High	1. All relevant drawings/documents & interface information to be sent by COMPANY PMT to respective project teams of interface projects 2. COMPANY to provide the requested interface information for ZK 300 3. Site surveys & data collection (as required) 4. Lessons Learnt under implementation in RE-FEED	1. CONTRACTOR to provide & COMPANY to send to interface team. 2. COMPANY PM 3. CONTRACTOR	1. Ongoing 2. Nov 30, 2011 3. As required	4	B	Med
33	5	EPC	Delay in placing order for long-lead items & delay in EPC schedule	Delay in freezing long-lead items	CONTRACTOR has identified a number of packages/items exceeding 6 months delivery period & the MRQ will be issued as per the requirements.	4	C	High	1. COMPANY to review & approve LLI list 2. COMPANY to float inquiry for MRQs issued by CONTRACTOR (if required)	COMPANY PM		4	A	Med
47	6	RE-FEED	Project delays	Integrity of existing facilities (due to addition/change of existing tie-ins)	1. Company Integrity department involved during critical project reviews	4	C	High	1. Changes to existing tie-ins or new tie-ins to be inspected by Integrity Department	1. COMPANY PM		4	B	Med

Table 6: Risk Register Template[95]

Findings from several Papers

As companies usually do not reveal their complete risk management strategies for various reasons, it remains interesting to detect single portions of their entire process. Here, we have several cases where tools and methods of single risk management steps are pointed out:

- Qatar Petroleum points out the fact that qualitative risk assessment does not focus on facts like financial numbers for the calculation of the prospective value of assets, losses or costs of a project. Qualitative analysis is focussed on determining relative values, risks and strategies for current and future projects. Therefore, they send out questionnaires and organize workshops to gather data from the key stakeholders. Assets and strategies that the company already has could be of advantage to the current project. Threats and opportunities are evaluated and estimated by identifying the risks, assigning probabilities and impacts and giving a hierarchy. *Methodologically speaking*, fault tree analysis and event tree analysis are used. While the fault tree analysis finds the origin of a problem by tracing it back to its root, the event tree analysis identifies possible outcomes of specific decisions. Also cause-consequence analysis is used by identifying the source of an event and determining all possible outcomes from that event. The ease of performing inaccurate (because of estimations) but quick calculations of sales and costs counts as one of the major benefits of these methods. On the disadvantage side we must say that decisions based on these vague calculations can cause problems with accounting and finance managers, who have to deal with inexact values.[96]

[95] Bensahraoui, M., et al., 2012, P. 3

[96] Rizwan, M., 2012, P.7

- The risk management plan of Kuwait Gulf Oil Company for the recovery of heavy oil from a reservoir in the Middle East points out several objectives: generating a risk matrix, evaluating business impact vs. resolvability, drive surveillance plans for managing risks, setting up a clear plan for a way for contingency and mitigation plans, establishing a work plan to address resolution options including cost, time to get data, resourcing and value of information.

  A total number of 66 risks and uncertainties were identified and ranked in 5 resolvability categories: impossible to resolve, difficult to resolve, moderately resolvable, highly resolvable and totally resolvable. Furthermore, they were ranked in two major categories:

  - Cost and schedule risks: business model, market conditions, regulatory issues, foray uncertainties
  - Execution risk: development pace, incomplete or ineffective project execution plan, project logistics, organizational capability.

  The workflow included following steps:

  - Framing the project and the problems: establishing a guidance document and ensuring stakeholder alignment, brainstorming, decision hierarchy and a strategy table
  - Deterministic analysis – determine what is important: sensitivities and deterministic comparisons, model for economic engine, document sources of major values and key drivers
  - Probabilistic analysis: cumulative probabilities, structure of decision tree and final decision tree
  - Evaluation – gaining insight to evaluate alternatives and recommend decisions: NPV, Expected NPV, discounted profitability index (DPI), value creation, oil reserves addition[97]

- The next example deals with major risks associated with the processing of explosive, flammable or toxic substances at TOTAL. A so called Scenario Based Risk Assessment is used where critical events are selected in the first evaluation step and studied in detail in order to establish the severity of damages and the probability of occurrence. For the detailed risk analysis, the Bow-Tie approach (causes tree – consequences tree and safety barriers) is a recommended method. Each critical scenario is assessed with respect to the company risk acceptance criteria based on a risk ranking matrix. The principals involved in the assessment and management of major risks are:

  - Risk identification: appropriate methods such as HAZOP, What-if, Checklists.
  - Preliminary risk evaluation: identification of initiating events and possible outcomes and consequences. The level of risk is qualitatively or semi quantitatively estimated.

[97] Choudhary, M. A., 2011, P.11

- Detailed and quantified risk analysis: detailed study of the causes of the selected scenarios, of prevention measures, mitigation measures and protection measures. Plotting on the risk ranking matrix.
- Risk assessment and ALARP demonstration: level 1 – first priority treatment, level 2 – tolerable of proved to be ALARP (as low as reasonably practicable), level 3 – generally acceptable.
- Development of a priority based program of improvements and of a major risks register: a summary of the risk analysis should be prepared for educational purposes.[98]

Throughout the lecture of various case studies, and many other papers regarding risk management procedures, we notice a basic structure. Risk management is built around the four main steps which are:

- Risk identification
- Risk analysis and evaluation
- Risk treatment
- Risk monitoring

These steps are a so called "fundamental structure". They may appear under other nominations or may be arranged in more or less steps, but the main concept remains the same.

We furthermore notice a predominant proactive view of managing risks. Companies/organisations rather focus on avoiding than running after an issue, which may be way more costly as shown earlier by the notion of "Front End Loading". A risk you can mitigate as early as possible will be less costly then fixing the outcome of an issue which may have great impact on reputation, money or even lives.

Poor information is given regarding the education of the so called "responsibles". We often have no insight about the training and education level of a risk manager or of others that must deal with risks on a permanent basis.

Last but not least, we notice throughout the entire lecture that a very small amount of information is available regarding the internal communication of risks. We often cannot put in evidence the flow of communication, whether Top-Down or Bottom-Up. This remains a topic which should be questioned and will therefore be included in the empirical survey, to which the results will be given later on in this thesis.

2.7 Conclusion

In the oil industry, it is becoming more and more complex to manage large capital projects. Nowadays, important reserves are being depleted and the industry is trying to compensate by drilling multiple smaller wells. The times of easy oil are over; therefore costs play a more and more significant role in the E&P industry. The notion of being economical has gained importance throughout the last decades. Oil and gas companies must make strategic decisions in order to decide which project should be followed and which one should be discarded, so that the company's best performance can be ensured. Key decision makers must

[98] Chetrit, A., 2008, P. 3

have the ability and possibility to review all information in order to prioritize capital projects. For the near future, several risks such as the access to reserves or markets can be given higher attention than to other risks. Challenges such as human capital deficit (aging workforce), cost escalation or competition from new technologies should not remain unobserved. These and many other factors play a significant role, therefore it is essential to have a very efficient risk management system, in order to either detect & treat risks, or enhance opportunities and realize them.

Nowadays, risk management plays a key role in project management; a large number of standards, terms, methods and software have been brought out and are the result of the consciousness that important changes can be made with an effective risk management.

One of the key findings within the literature review is the fact that the attitude of the responsibles is an important success factor for the systematical handling of risks. In order to make an intelligent decision (avoid, reduce, share and accept), discussions must occur between the team. Senior management should be adequately informed of their options and the cost-benefit arguments for each possible action. Therefore, a proper flow of information must be ensured, the notions of top-down and bottom-up are of great importance. In the literature, we recognize that the risk management process should not be isolated as a subdiscipline of project management; it needs an integrated approach. To achieve a comprehensive risk management, in a bottom-up procedure the development of the single projects should be consolidated, resulting in a complete risk profile for the entire company.

There are many tools and methodologies how to perform the task of risk identification, analysis, response and monitoring. Important resources such as time, money and education of the personnel play a significant role whether a method/tool is used or not.

Summarizing, the literature shows us that risk related communication within the company as well as the education level of the responsibles are of great importance, but at the same time poor valuable information is provided in order to assess these factors. We furthermore notice a broad range of methods and tools, but no generalization can be made regarding their use at a given stage of the risk management process. These few critical points will therefore be subjected to the survey later on in this thesis.

3 Benchmarking

3.1 Introduction

What do others do better, and how do they do it better? Benchmarking is nowadays a common method of comparing performances and practices either within a specific industry, or within several industries. It is a continuous process of measuring products, services and practices, in order to learn from the best and establish a competitive leadership position in a given area of business. The Oil & Gas industry offers rapid changes brought through improvements in communications, technologies and strategies (and many other factors), and requires the awareness of best practices, which can be provided by benchmarking. Therefore, benchmarking is defined in following manner:

"A measurement of the quality of an organization's policies, products, programs, strategies, etc., and their comparison with standard measurements, or similar measurements of its peers.

The objectives of benchmarking are:

- to determine what and where improvements are called for,
- to analyze how other organizations achieve their high performance levels,
- to use this information to improve performance."[99]

It is the process of identifying best practices, in order to understand and evaluate the current position of a business or organization and to identify areas and means of performance improvement.

With the title of this master thesis being "Benchmarking Risk Management in E&P Capital Projects", it is important to know why, how and where benchmarking is performed.

3.2 Basics

Benchmarking is nowadays used as a technique for marketing or quality measurement in order to analyze management techniques and organizational methods of other companies or organizations. It is a continuous process of research, comparative analysis, adaptations and implementations of best practices so that the own performance is improved. A benchmark may be considered as a comparison indicator in a given area such as quality, productivity, and speed or time loss, taken from the study of "the best in class". These may then serve as new objectives an enterprise would want to achieve.

In the end of the 1970's, Xerox, which currently is an American multinational document management corporation that produces printers, multifunction systems, photo copiers, digital production printing presses and gives consulting services, started a new method for management in order to have competitive advantages. This was the period when benchmarking was more or less "born", with a program called "competitive benchmarking". The own copy machines were systematically compared to copy machines from competitors, with the focus set on performance indicators, range of functionality and production cost.[100] Generally, the term has its roots in the construction industry, where reference points where engraved on rocks in order to measure distances such as heights and lengths. Later on, engraving a mark on a bench developed itself as

[99] www.BusinessDictionary.com
[100] Sabisch, H.,1997, P. 11

meaning "this is where we stand, here are the others". Therefore, Benchmarking is often understood as a reference point, which can be considered as a goal an organization wants to achieve.[101]

In the context of benchmarking, we often encounter the term "Best Practice" which should be understood as the best procedures and best processes for a certain achievement. Therefore, it is of great importance to differentiate between a benchmark (reference point) and benchmarking (the search for these reference points, implementing improvements and attainment of the reference points).

Therefore, several key definitions of benchmarking must be given:

- It is a continuous process of measuring products, services and practices, and the comparison with leading companies/organizations.
- It is the search for best practices which result in top performances, in order to implement these best practices for own purposes.
- It is a target-oriented and continuous process, where the objects of comparison come from different branches. These objects of comparison may be products, services, business processes, methods or activities.
- The differences between the activities and areas of optimization must be explored.
- Benchmarking is an opportunity for an organization to benefit from the experience from others and to avoid mistakes.[102]

What Benchmarking is	What Benchmarking is not
An element for a global strategy	Industrial espionage
A way to analyze the own company	Business intelligence
A state of mind	Stealing information
A method, a technique	Simply copying best practices
A tool to enhance processes	

Table 7: What Benchmarking is[103]

Functions of Benchmarking

Benchmarking can be used for various reasons, it is important to identify the function this tool should fulfill, in order to answer the preliminary questions. Four main functions can be identified, with following guiding questions:

- Measuring and scaling: Where are we and where is our competitor? Which are the "best in class" solutions of problems? How will the trend regarding solving problems be in the future?
- Awareness: What do the others do better than we do? Why is it better and what are the reasons? What measures can we adopt? Which adjustments must be undertaken? How

[101] Wochesländer, C., 2006, P. 10
[102] Wochesländer, C., 2006, P. 10
[103] Krebs,Y., 2001, P. 2

may best practices be used in order to use them as starting point for own creative solutions?

- Objective: What changes must be undertaken, in order to enhance the market position? What goals should be set for long term/short term improvements? Do we want to become best in class? Which requirements must be fulfilled in order to enhance the improvement process?
- Implementing: What measures are required to accomplish the planned changes? In which areas would it be smart to enforce improvements?[104]

Types of Benchmarking

We basically distinguish between two sorts of benchmarking approaches. Regardling to the methods or tools one wishes to use, or even the goal one would want to achieve, benchmarking can be firstly divided into two major categories. Whether the source of information and data is coming only from the own company/organization or not, we talk about internal or external benchmarking. We distinguish in these two categories because of the then achievable goals through the value of information given. If the aim is to learn more about best practices within an entire industry, internal information will not lead to the desired goal. Therefore, there must be a clear separation between internal and external information resulting in internal and external benchmarking.

Internal Benchmarking

Internal benchmarking is the comparison within the own organization/company. A corporate for instance has the possibility to benchmark its sub companies, in order to assess which one has the best performance. Also, departments, groups, specific areas or businesses can be compared. By always having a critical view on its own business, managers may have access to all details of operations, something that wouldn't occur if they were looking outward. Additionally, an internal review might be more realistic in terms of a company's capabilities and limitations. Furthermore, comparability, transmutability and the simplicity of transferring process models are outstanding and count as strengths of internal benchmarking. On the other hand it is a method which does not offer extraordinary new results and big innovations, because of the similar corporate wide culture, rules and processes. The angle of view is more or less the same, offering only corporate wide knowledge without any influence from outside. Other aspects such as prejudices, the fear for changes and finger-pointing, and the resistance to expose department-intern knowledge, may also play a negative role regarding internal benchmarking.

Therefore, internal benchmarking projects often stand as the beginning for a further benchmarking project which then involves an external benchmark. The strategy may be to first gather the required understanding and knowledge for an internal companywide process in order to understand other companies in a second step. Only when one is able to fully understand his own processes, he can analyze the processes of other institutions.[105]

Following reasons justify internal benchmarking:

- To standardize approaches and procedures
- To open channels of communication within an organization
- To determine priorities based on the results of the benchmarking

[104] Sabisch, H., 1997, P. 14
[105] Wochesländer C., 2006, P. 30

- To identify the most important driving forces
- To clarify procedures
- To identify weaknesses within procedures
- To enhance all procedures to a highest possible level[106]

It is the easiest form of benchmarking regarding the access to valuable information. One of the biggest sources for inefficiency is the fact that the same work is done twice or more times within an organization, without that the separate departments know from each other. Internal benchmarking offers the possibility to have insight into the own structures, and to learn all about them.

External Benchmarking

External benchmarking stands for a comparison between products, processes and services in various areas. As the name includes the term "external", we notice that it differs itself from internal benchmarking as the focus is set on external happenings which do not concern the own institution. Here we distinguish between three types:

- Benchmarking of the competitors: this includes competition benchmarking which analyses and compares products, processes and services from direct competitors. It is often performed by consulting firms in the name of a company. Consulting firms usually have an easier access to critical data and can handle valuable information neutrally and anonymously.
- Benchmarking within the same industry: Mainly has the same goals like competitor benchmarking, but within a specified industry. The aim is more to identify trends and performance of subsystems and processes. Therefore a broader range of companies must be benchmarked.
- Benchmarking independently from the industry: The key to sustainable success under competition is not similarity, but superiority.[107] It is about finding actual best practices, catching up and overtaking. This sort of benchmarking consists of analyzing and comparing within different industries. Gathering data from the competitors within a single industry is way more difficult than from a different industry. A "best in class" company would rather give away precious information to a company from another industry then to a direct competitor. This concerns project related data as well as R&D related matters. The willingness to share sensible data, which could bring a lot of innovation to a company, is higher when the companies do not operate the same industry.[108]

Differences of Benchmarking Types

When performing the task of benchmarking, we notice three basic differences of benchmarking types (see Figure 12):

- Benchmarking of company activities: Can be categorized in internal and external benchmarking whereas the external includes competitive, industrial and industry-independent benchmarking. Companies learn from other companies or from the own practices through comparison of the key performance indicators and through the exchange of in-

[106] Wochesländer C., 2006, P. 31
[107] Mertins, K., 2009, P. 40
[108] Wochesländer, C., 2006, P. 31

formation. Best practices are identified and implemented when possible. Internal and external approaches can be used in combination with each other.

- Benchmarking of areas/sectors: The performances of complete business areas are compared in order to learn from best practices.
- Benchmarking of environment: This includes analyzing political aspects, sociopolitical aspects and economical guidelines, so that countries or regions may learn from each other.[109] Here as well, internal and external approaches can be used individually or in combination with the other.

Usually, benchmarking is performed by a single company, but in some cases a group of companies decides to carry out a so called "collaborative benchmarking". Hereby, valuable resources such as time and money can be saved, which could be a show stopper in some cases when it comes to performing benchmarking.

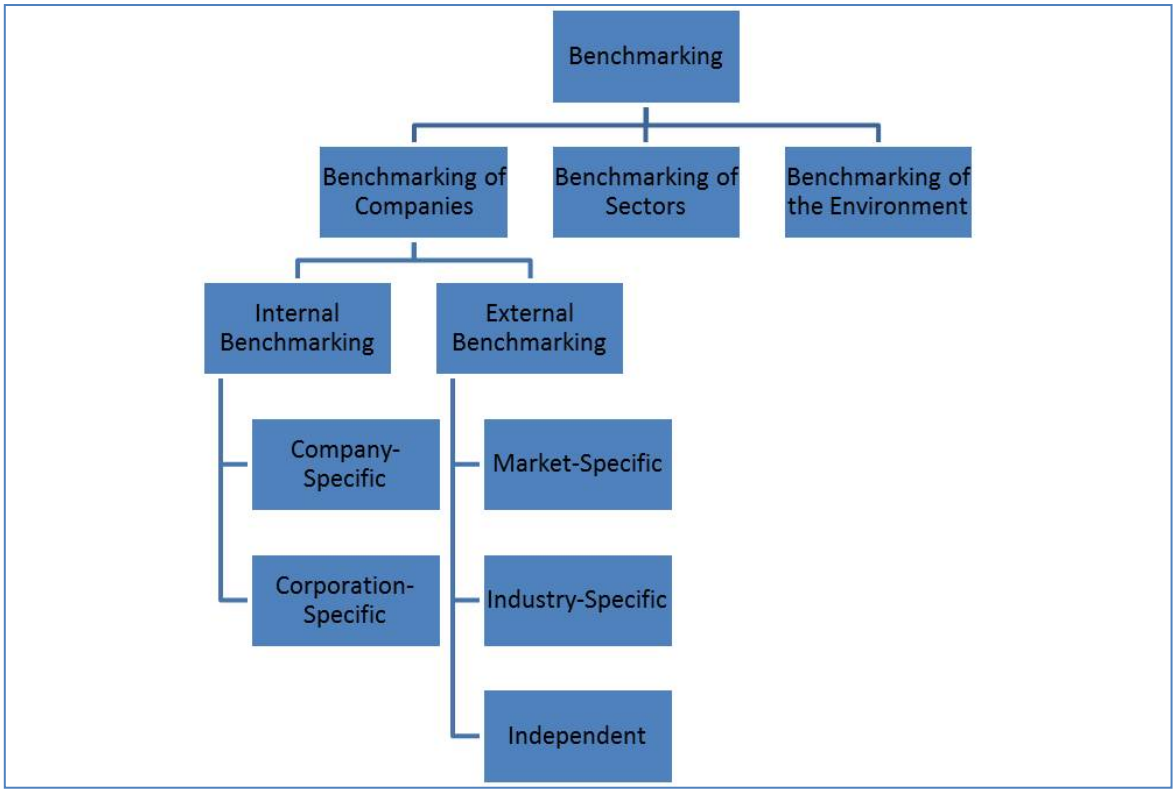

Figure 12: Benchmarking Types[110]

In order to make a meaningful comparison, there should be similarities within the processes. The objects of comparison must be clearly examined and described; similarities must be found within the companywide object and the external object. Only then, a rational comparison and the identification of room for improvement can be found. The following table describes the advantages and disadvantages of the benchmarking types (Table 8):

[109] Mertins, K., 2009, P. 31
[110] www.globalbenchmarking.org

Type (Benchmarking Partner)	Advantages	Disadvantages
Competitive Benchmarking (best in Competition)	Access to data; Good results for diversified companies	Limited perspective; Internal prejudices
Benchmarking within same Industry (best in class)	Business-related information; Products and processes are comparable; High acceptance; Clear positioning in competition	Difficult data gathering
Benchmarking independently from industry (Best practice)	High potential for innovative solutions	Difficult to transmit external ideas into the company; Time consuming analysis

Table 8: Advantages/Disadvantages of the types of Benchmarking[111]

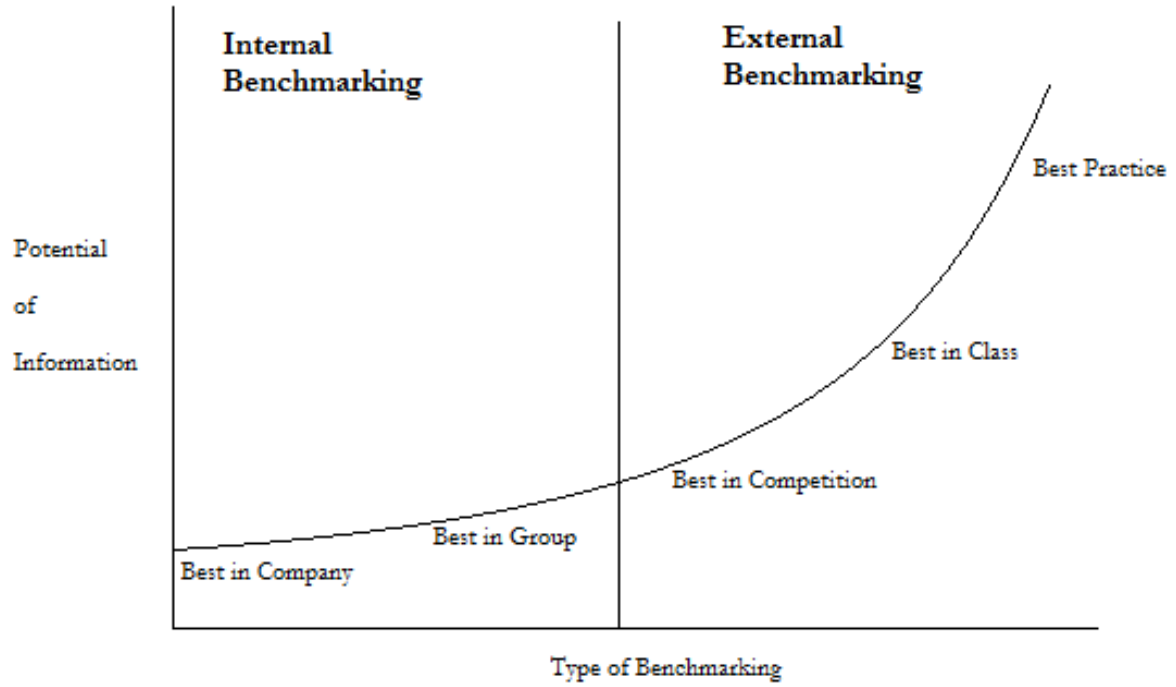

Figure 13: Room for Improvement related to the Benchmarking-Partner[112]

As we can observe in Figure 13, external benchmarking offers a greater potential than internal benchmarking in acquiring valuable information, due to the fact that new ideas and new learnings can be identified. This information coming from "outside" may be incorporated and used in order to reach the level of the best in competition, best in class or even best practice.

Performance Indicators

When performing a benchmark, several key figures play a role, depending on the complexity and magnitude of the analysis. Monetary and non-monetary figures have an impact on the results and can be listed in following categories:

[111] Mertins, K., 2009, P. 41
[112] Kohl, H., 2009, P. 91

- Indicators regarding quality and customer benefit: reliability, key performance indicators, faultlessly, lifespan, and key indicators for standardization.
- Indicators regarding resources: consumption of material, consumption of energy, employment of staff.
- Costs and prices: original cost per unit, process cost, project cost, cost structure, cost and price development, etc…
- Indicators regarding value-for-money ratio
- Indicators regarding time: Time to Market, duration of R&D, Break even time, phase and process duration, delivery time, cycle time, transport duration, repairing time, standstill time, etc…
- Productivity: unit of quantity per unit time, revenue per employee, revenue per developer
- Efficiency and profitability: ROI, payback time for investments, NPV
- Environmental sustainability: emissions, waste, noise, degree of reutilization
- Indicators of quantity: amount of components, modules, parts, amount of customers, deliverers, orders, amount of process steps, amount of projects
- Revenue indicators: revenue (total), revenue from new products
- Growth indicators: increase (decrease) of revenue per year, increase (decrease) of productivity, quality, decrease (increase) of costs, decrease (increase) of rate of failure
- Indicators of allotment: share of new product regarding total revenue, share of new products regarding profit, share of high quality products regarding revenue, age distribution of all products.[113]

The wide range of criteria clarifies the fact that benchmarking studies can offer a wide range of results, and therefore can be more or less time consuming. It is therefore of great importance to choose the qualitatively right indicators in order to find the perfect balance between time consumption and efficiency.

Methodologies

Benchmarking has gained great acceptance since Xerox began to perform it early 1980's. Since then, many companies have used this tool in order to enhance the output of their businesses. The increasing demand for benchmarking has also led to a vast range of methodologies; therefore there is no single process or methodology which is adopted universally.

The method used lies within the responsibility of the quality manager who decides according to the magnitude of the project. In any case, benchmarking requires several months of internal teamwork, and sometimes also from external teams which are not directly attached to the company. It is a group work, with the condition that each individual is aware of the processes of planning, analyzing and solving problems.

As mentioned before, many methods and techniques exist. They more or less find their roots inR.C. Camp's benchmarking concept which was used during the beginnings of benchmarking within Xerox Corporation. Camp divides his approach in five phases:

[113] Sabisch, H., 1997, P. 24

- Planning
- Analyzing
- Integration
- Action
- Maturity[114]

He breaks down the task in ten defined points, which are described in the following figure. This Benchmarking method is meant to be performed in a team, which stands as an independent institution within the company.

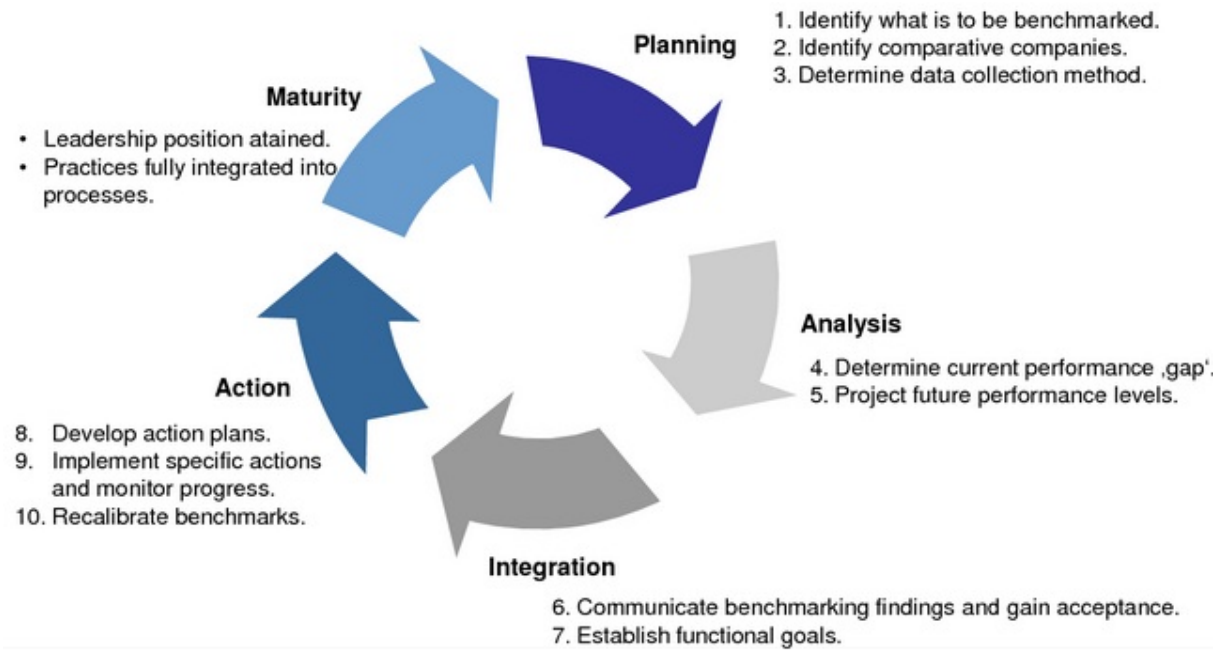

Figure 14: Benchmarking Phases[115]

During the planning phase, the driving questions are:

- What should be benchmarked? We distinguish between Product benchmarking, Process benchmarking and Strategic benchmarking.[116]
- Who should me benchmarked? Many targets come in question such as public, private, state owned, big, small, medium, national or international companies. The target is not

[114] Camp, R. C., 1994
[115] Schermer, H., 2005, P. 8
[116] Umland, J., 2008, P. 2

chosen by preferences or contacts, but because of their outstanding performance in a certain area.[117]

- How should it be conducted?

The benefits must be clearly defined for each participant, a Benchmarking team must be formed and a Status Quo of the to-be-benchmarked object must be documented.

The goals, the activities to be compared and the methods should be well-defined. Processes with potential for improvements must be identified. This may take several months and consume resources. Therefore it is very important to identify the correct processes which should be benchmarked.

The analysis phase is defined by the focus on current and future performance. The right key performance indicators must be defined.

The phase of integration is carried out by communicating with everybody involved and increasing the acceptance level. Furthermore, well defined goals are set to offer perfect prerequisites for the execution.

The execution is then performed during the action phase. Action plans are developed. Here, working packages as well as milestones are defined, and an efficient controlling ensures transparency which leads to top motivation. Collecting, handling, analyzing and comparing all data will be part of this phase. The gap must be identified; numbers must be translated into comprehensive facts.

The maturity phase occurs once a practice acquired from benchmarking has been adopted in the company.

Camp distinguishes between qualitative and quantitative benchmarks. A qualitative benchmark is the comparison of practices and methods, while a quantitative benchmark compares the key performance indicators.[118] In his later publications, he also defines a third type, called process benchmarking which focusses on working processes and operative procedures. Like this, best practices can be defined and can be implemented into other processes.[119]

In the following table, a summary of twelve benchmarking methods such as the one from R.C. Camp is given in order to have an overview.

Method	Procedure	Organization	Benchmarking Object
R. C. Camp	10 Steps; Main Phases: Planning, Analysis, Integration, Action, Maturity	Benchmarking Team, Integrated as a constant institution within company	Practices, Procedures, Processes
American Productivity & Quality Center	4 Phases: Plan, Collect, Analyze, Improve	Benchmarking Team	Mainly for Business Processes

[117] Umland, J., 2008, P. 4
[118] Wochesländer, C., 2006, P. 57
[119] Umland, J., 2008, P. 11

G.H. Watson	4 Phases: inspired by Deming circle (Plan, Do, Check, Act)	N.D.	Mainly for Business Processes; Based on TQM
C.E. Bogan, M.J. English	5 Phases	Change strategy influences the pace execution	N.D.
B. Karlöf, S. Östblom	5 Phases	Normal project organization: steering committee, project manager, team	Products, Services, Business processes, Cost Structures, Costumer Benefits
W. Kreuz	7 steps, Internal data gathering and analysis, external data gathering and analysis	Team and Clearing House or external consultants, experts	Strategy, Process, Function
R. Pieske	2 Main phases with four sub items each (analysis and implementation)	Team, depending of the benchmarking object	Product, Process, Venture
H. Wildemann	4 Phases: Identification, Analysis, Improvement, implementation	Interdisciplinary team	Practices and Methods
J.H. Harrington	5 Phases with 20 activities, internal data gathering and analysis, external data gathering and analysis	3 Benchmarking teams for different phases	Business Processes[120]
K. Mertins, G. Siebert, S. Kempf	5 Phases: Goal setting, internal analysis, comparison, measures, implementation	N.D.	Benchmarking across the Industry
J. Weber, B. Wertz	3 Main Phases with four detail phases	Benchmarking Team for special requirements	N.D.
Konsortial Benchmarking	5 Phases	Consortium and experts	Not defined, Main Theme must be given

Table 9: Overview over 12 Benchmarking Methods[121]

[120] A Business Process is a procedure in which objects are processed or transformed. Therefore, the objects are either Products, Assignments or Resources

[121] Wochesländer, C., 2006, P. 94

Benchmarking is related to target setting and is treated as a component of the formal planning process. As noticed above, some authors have modeled the benchmarking process on the basis of the Deming cycle (for example G.H. Watson), which is a continuous looping model composed of four elements: plan, do, check, and act.

We also notice that the models may have different number of phases, under phases and activities. As Camp has proposed to utilize a ten step generic process for benchmarking, Kreuz offers to have 7 steps while Pieske systematically needs two. It involves a judgment process of which functions or firms are to be benchmarked, and the continuous search for best practice for setting new performance goals in achieving performance superiority.[122]

Benchmarking in the Oil and Gas Industry

The oil and gas industry is a wide, global industry which includes exploration, production, transporting, refining and retailing. It is linked to many other industries, which are dependent to energy and products based on petroleum. The broad range of business areas and the globalism of this industry offer an enormous potential for benchmarking studies within all disciplines.

Benchmarking has the potential to identify and assess the gap between two companies, the sponsoring company and the best-in-class one. Best practices can be so important that by implementing them, a company could save a significant amount of money.

As mentioned before, benchmarking can be performed for a broad range of business areas. Drilling performance for instance, offers many benchmarking opportunities. Productive time, non-productive time, invisible lost time and flat time can be compared to best practices in order to save expenses and increase efficiency. Other cases such as bit performance, directional drilling or drilling fluids can be benchmarked too. There is always room for improvement, which can be pointed out by benchmarking.

Other benchmarking areas in the petroleum industry (just to name a few), regardless from the project phase, are:

- HSE
- Petroleum products
- Efficiency of refineries
- Enhanced Oil Recovery methods
- Artificial Lift Systems
- Digital Oilfields
- Contractors

[122] Fong, S.W., et al. (1998), P. 6

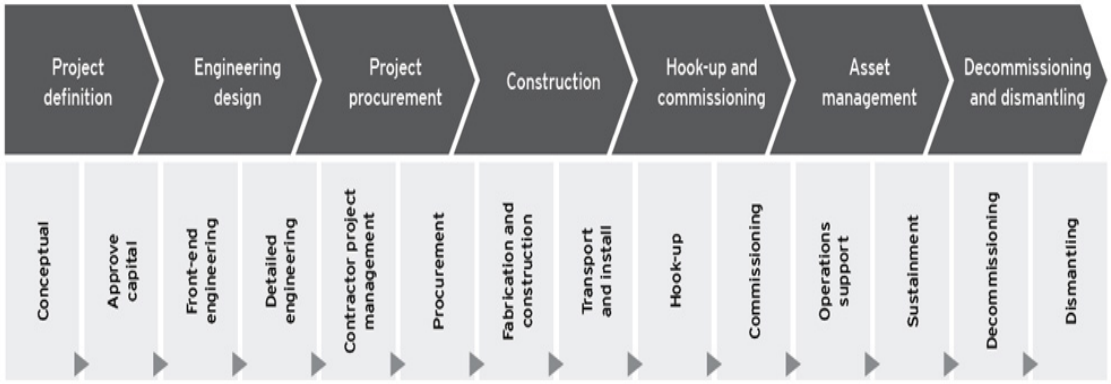

Figure 15: Capital Projects Life Cycle[123]

Below are a few cases presented which demonstrate the use of benchmarking in the industry. A benchmarking study about the "determination of current industry practices in the production-measurement and automation area (PMA)" in the year 2007 provides guidance to oil- and gas producing companies desiring to increase their productivity through PMA projects.[124]

The methodology chosen resembles to the one offered by the American Productivity & Quality Center (see benchmarking methodologies overview) with following activities:

- Developing a comprehensive questionnaire to assess people, processes and technological aspects of each company interviewed.
- Identifying and analyzing the sponsoring company's own practices
- Assessing the status of a selected industry's peer-group participant companies in these areas.
- Comparing participants positions with that of the peer group and identifying opportunities to improve.[125]

Therefore, a survey was performed which promised confidentiality for the participating companies. Quantitative questions were asked, which can be converted into numerical values. Scoring was based on the responses from the participants ranging from 1-5 (1 lowest, 5 highest). These scores are later on averaged per subarea measurement category and result in subarea score, which is then plotted in a spider diagram. Like this, a direct comparison can be made between the own company and the industry-average or best practice.

[123] Ernst & Young, 2013, P. 1
[124] Liddell, B., 2007, P. 1
[125] Liddell, B., 2007, P. 1

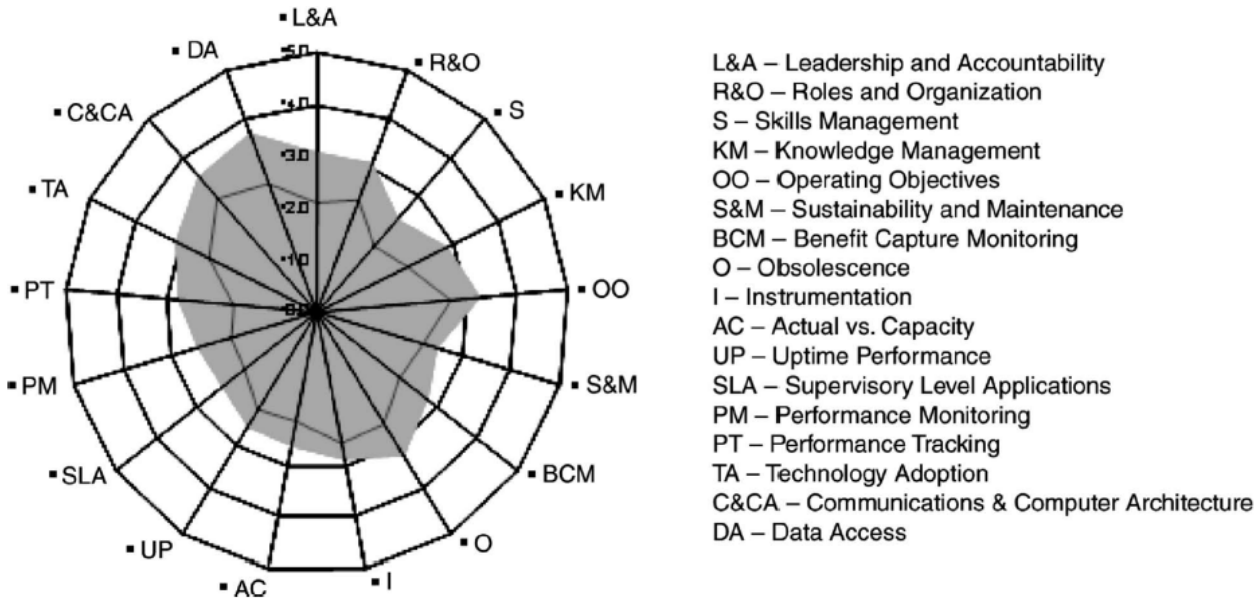

Figure 16: Example: Participant vs. Industry average[126]

Another benchmarking study has been conducted by BP in 2008, in order to find "core" oil and gas industry health indicators, which enable more informed comparisons and dialogue between companies and stakeholders. Metrics and measures related to people, processes and plants have been reviewed and considered as means to ensure safer workplaces and the ongoing management of risks to people.[127]

For this, following methodology steps are chosen:

- Identifying existing leading and lagging health indicators
- Obtaining external benchmarking data on other global organizations that have similar programs
- Undertaking internal benchmarking of BP's people and systems for current processes
- Analyzing the benchmarking information against BP's own internal data and identifying the gaps as well as the process and system to fill those gaps
- Implementing a system of capturing, processing and presentation of Management Information to Managers so as to ensure mitigation of risks.[128]

The internal web based survey was sent out on people within a business unit or strategic performance unit in BP, while the external web based survey was focusing on senior health executives (such as a Vice President of Health) from external organizations. The external survey was performed by a consultancy company due to their experience with surveys of similar size and the number of contacts they already had. The consequence was a high level of feedback on strategy and operations from the external survey with more detail and local focus from the internal survey.[129]

[126] Liddell, B., 2007, P. 2
[127] Sortland, G.W., 2008, P. 1
[128] Sortland, G.W., 2008, P. 2
[129] Sortland, G.W., 2008, P. 2

Based on the main results of the external survey, BP learned that no organization currently has a good handle on meaningful leading and lagging indicators, although it was clear that many were working towards that objective and showed a strong desire to have a more comprehensive set of indicators to mitigate future risks. The internal survey showed that despite the differences between local health concerns and gathering of metrics, there is opportunity to further improve the process for developing and gathering local data which can be reported at a global level.[130]

In the SPE paper "Benchmarking Safety KPI's – Enhancing Safety Performance", the authors point out the importance of HSE due to its linkage to every organization's business model. Demands on the oil & gas industry are driving continual improvement in HSE performance, which in turn the business performance of an organization. They point out the fact that benchmarking in safety is planned and structured, with following goals:

- Reducing incidents
- Improving compliance with organizations HSE Management Systems procedures or laws
- Enhancing safety culture
- Reducing costs associated with compliance[131]

The proposed approach is similar to G. H. Watsons approach based on the PDCA Cycle (view table with 12 benchmarking methods). This plan-do-check-act cycle from Deming, applies to every sector, business and activity and has following benchmarking phases:

- Defining what to benchmark
- Analyzing the present position
- Choosing Partner/performance with whom we need to benchmark
- Working with partner/performance
- Acting on lessons learned[132]

When analyzing the present position, the organization's performance report and audit reports are taken into consideration, and a survey among employees is conducted as well.

Partners are selected either internally or externally, in both cases advantages and disadvantages exist.

The most important aspect in benchmarking is continuous improvement, where opportunities for improvement must be followed up for implementation and need to be tracked and monitored regularly.[133]

KPI's

In order to measure a company's success or the performance of processes, Key Performance Indicators must be established. KPI's are "detailed measures established to assess and shape pro-

[130] Sortland, G.W., 2008, P. 5
[131] Al Abdul Salam, A., 2012, P. 2
[132] Al Abdul Salam, A., 2012, P. 2
[133] Al Abdul Salam, A., 2012, P. 4

gress toward achievement of strategic objectives of an organization that usually incorporate or align to organizational objectives, project milestones, incident rates, budgets and target levels of customer acceptance".[134] Risk management KPI's involves establishing lead indicators which can measure performance before occurring events and guide the development and application of new or ongoing risk mitigation strategies. The main objective is to support business integration which means the achievement of organizational objectives, and provide assurance regarding quality requirements.

In order to set up KPI's for the continuation of this work, a few guidelines must be respected. So called SMARTS KPI's should be:

- **S**pecific: What exactly do I expect?
- **M**easurable: What is the unit of measure? (Percent, quantity, quality, trend)
- **A**ctionable: What needs to be done to deliver the expected outcome?
- **R**ealistic: Are the infrastructure and resources in place to deliver this?
- **T**imely: When or how often will this KPI be assessed?
- **S**imple: Can I explain this KPI to everyone who contributes to it?[135]

It is of great importance to choose the right KPI's, therefore a good understanding of what is of importance to the company is a prerequisite. Importance can be defined by the choice of the department: performance indicators for technical processes differ from those in finances. Potential improvements can only be done by identifying, assessing and working on the parameters of each key performance indicator.

The choice of the right KPI's can be performed by using a Balanced Scorecard, which is a simple summary of financial as well as non-financial actions, which can be easily compared to so called "target values". Important information, as well as the company's vision and mission can be captured in relatively short time. Kaplan and Norton[136] have been the pioneers for the articulation between performance measurement and the company's production function. With the help of this management tool, a good overview over the "links between leading inputs (human and physical), processes, and lagging outcomes" and a good focus on "the importance of managing these components to achieve the organization's strategic priorities", are given.[137]

For benchmarking risk management in E&P capital projects, a number of KPI's must stand out. We can record and assess performance using a range of qualitative or quantitative measures, which can be challenging due to the wide range of accessible data, wherein useful information must be found. Out of all the potential measures, there will always be KPI's that deserve special importance. Lakein138 formulated the 80-20 rule based on an application of the Pareto principle pointing out that 20 percent of the data will hold 80 percent of the value. Furthermore, the Professor Miller stated that human beings can hold 7 +/- 2 things in mind easily[139], which gives us a rule of thumb that suggests we should work toward managing more or less seven KPI's per business area.

[134] Talbot, J., 2012, P. 8
[135] Talbot, J., 2012, P. 21
[136] Kaplan, R.S., Norton, D.P.,1996
[137] Abernethy, et al., 2005, P. 1
[138] Lakein, A. 1974
[139] Miller, G.A.,1956, P.87

3.3 Survey

A survey is a way that enables the collection of information directly from people in a systematic, standardized way. In the course of the survey all participants get the same questions. The gathered information can be about the participant's opinions, knowledge, attitudes, beliefs, behaviors, plans and backgrounds. This tool is used for needs assessment and opinion pools and is used to collect information from a number of people.[140]

Open/closed questions

The questionnaire must be held short and simple, with a mix of closed questions and open questions. The designer of the questionnaire must decide whether a question is open (free answers) or closed (given answers). While most questions are usually closed, some few open questions may have the biggest importance.

Open questions are analyzed in a way, which differ completely than answers from closed questions. Recording and categorizing the answers take more time than for closed question, which consequently may have an impact on costs. Important aspects are:

- When measuring quantities with open questions, no set of closed quantity categories is given (example: less than 1h, 1-3h, more than 3h), which can reduce errors and deviations.
- When measuring judgments (for example an opinion), the researchers sometimes try to combine open and closed questions by simply adding the option "other" to the answer options of a closed question.
- The list of choices offered by closed questions suggests that a relatively high number of participants would have mentioned similar values to an open question form.
- Closed questions generally suffer more than open questions from correct guessing, which is due to the easiness of answering given questions than spending time thinking and writing down the own opinion.
- Open questions attract more likely than closed questions the answer "I don't know" from participants who actually know the correct answer but are not sure they do (due to the preference not to speculate and risk embarrassment). This may be also due to the fact they do not immediately remember the correct answer, and the effort trying to remember is too high.[141]

Generally, we notice a bigger emphasis on closed questions rather on open ones, which nevertheless are way more time consuming and therefore could lead to less valuable results. Otherwise, open questions are an outstanding way to collect opinions, mindsets and suggestions. Closed questions are easier to handle, enabling a categorization of answers (example: yes/no).

The sequence of a survey should follow two guidelines:

- From general to specific, and
- From simple to abstractly[142]

[140] Taylor-Powell, E., 2000, P. 3
[141] Krosnick, J.A., Presser, S., 2010, P. 267
[142] Leitfaden für die Erstellung eines Fragebogens, P. 8

It is important to phrase significantly clear questions, so that the participants do not doubt if they understood them or not. Specific words, other languages and abbreviations will be avoided. The participant should be able to answer the question without influencing him/her negatively (motivation).

Two issues should not be discussed within one question (such as: what methodology is used and how satisfied are you with the current methodology?)

Regarding the proposed answers for closed questions, the amount and the way must be well thought-out. The literature distinguishes between two categories:

- Even number of answers: Here, no middle question is offered which could be used as neutral point. Answers such as yes, rather yes, rather no and no will require a tendency for those participants, who do not have positive or negative feelings. Nevertheless, an advantage is the possibility to later on use the data and categorize the answers in two classes (example: approval, refusal)
- Uneven number of answers: Here, the difference is the presence of a middle answer, which participants may use in case of indecision or neutrality. The disadvantage may be that the participant may use this option whenever they do not what to answer, therefore no tendency can be noticed.

Rating Scales

The purpose of a rating scale is to assign quantitative or qualitative attributes to given information. The researcher specifies the number of points on a scale, from which the participant will chose one. Literature offers a wide range of scaling methods, such as Likert's 5 point scaling method. Others such as Osgood, Suci and Tannenbaum use a 7 point semantic differential method. Thurstone uses 11 points, and Miller even uses a 101 point rating scale. We can see that opinions regarding rating scales are scattered, with reliability and validity playing a major role for the choice.[143]

The key to answering a question with the help of a rating scale is that the respondent executes a matching or mapping process. The own attitude must be assessed in conceptual terms, to find a point on the rating scale that most likely matches that attitude. This requires a full range of points offered to cover the entire measurement without bypassing any regions. Furthermore, all points must follow a strictly ordinal, progressing form without overlapping. The respondent must have a minimum of understanding of the meaning of each point of the scale. Whenever these conditions are not met, the quality of answers will suffer.[144]

Treatment of No Opinion

When respondents are asked to answer a question to which they do not know the answer, they ideally would say that they do not know the answer. Nevertheless, some respondents wish not to appear uninformed, which results in them giving an answer to satisfy the interviewer. Therefore, some researchers recommend introducing the "don't know" option for a given set of answers within a closed question. This way, respondents are aware that it is an acceptable value to say that they have no information in order to answer the question.

The use of this option has advantages and disadvantages. On the one hand, this option successfully encourages participants without information to admit it, and on the other hand, the option

[143] Krosnick, J.A., Presser, S., 2010, P. 268
[144] Krosnick, J.A., Presser, S., 2010, P. 268

may go too far and discourage people which do have information for meaningful results and do not express it.[145]

Question Order

A survey may not only be affected by the formulation of the questions. The right choice of the correct series of questions may lead to better results. Question order has two major attributes

- Serial: location in a sequence of items
- Semantic: location in a sequence of meanings

Both have an influence on cognitive processes triggered by questions.

Serial order influences in three ways: affecting motivation, promoting learning and producing fatigue. The beginning of a survey is the most crucial segment, where the likelihood to influence willingness to respond is high. The respondents understanding of what the survey is about can be easily shaped. Therefore, a questionnaire's beginning must offer a strong connection to the topic and purpose, which are commonly described during the introduction. The aim is to gain interest as well as to impose a burden to the respondent. Therefore, a set of easy, closed questions must be part of the very beginning of a survey.

Throughout the questionnaire, items must flow coherently. Therefore, items on related topics must be grouped together. Coherent grouping can facilitate respondents' cognitive processing by specifying the meaning of a question more clearly or making retrieval from memory easier.[146]

Evaluating

After all submissions are gathered, data is analyzed and handled. Answers must be identified and the appropriate type of analysis must be chosen, such as:

Aim	Analysis
Reporting the number of people who answered the question	A count
Reporting how many people answered "a", "b" or "c"	A frequency (number of times a given response occurs)
Reporting what percentage of people answered "a", "b" or "c"	A percent distribution (proportion of respondents selecting each response)
Reporting an average score	A mean (average of numeric responses or scores)
Open-end questions	Content analysis (process to organize open-ended, unstructured information)

Table 10: Proposed analysis for evaluation type[147]

The goal of a survey is to evaluate strengths and weaknesses of a process. Impact and outcome of a questionnaire must be analyzed. Many questions must be asked such as:

- How many respondents?

[145] Krosnick, J.A., Presser, S., 2010, P. 282
[146] Krosnick, J.A., Presser, S., 2010, P. 291-292
[147] http://www.nationalserviceresource.org

- What achievements are gained through the responses?
- What are the strengths and weaknesses of the research results?
- How can the actual practice be changed?

Following chapters will show us the results of the survey, how data has been processed and what the learning will be in order to gain valuable information for **OMV**.

3.4 Practical Part

We are interested, in this thesis, in benchmarking risk management. However, the aim is to compare **OMV**'s processes and risk management performance against internal measures, industry standards and best practices from best-in-class companies. Nevertheless in doing this, we may face some important questions such as:

- Are we comparing like with like?
- Can we define risk management in two different organizations?
- Can we trust the people who are providing the comparisons?
- Have people just given us easily available numbers or have they worked hard on them?
- How will we encourage people to share sensitive information?
- How do we separate different levels of information within different organizations?
- How do we fairly compare organizations of different sizes?

Anyways, despite all these questions, benchmarking studies can be the beginning of a successful change program, offering good opportunities for improvement.[148]

Benchmarking can be an expensive or lengthy process. The first steps, as aformentioned, consist of a clear definition of the objectives and scope accompanied by a statement of the anticipated benefits.

In this Master Thesis, we have chosen to perform **external benchmarking within the same industry**, in order to compare the risk management processes for capital projects within the E&P industry. This thesis will specifically investigate the following research questions:

- What are the likely key factors (quantitative: demographic variable such as enterprise size; qualitative: the managements knowledge or personal attitudes) that influenced risk management practices in the E&P industry?
- What are the methods and techniques used in the various steps of the risk management process?
- How is risk management incorporated into the company's organizational structure?
- At which phases of a single project are risk management techniques utilized?
- How is a possible interface between single project risk considerations and the risk profile for the entire enterprise developed?
- In which way has the risk management process been linked to the business planning?

[148] Mainelli, M., 1999, P. 1

Research Questions	Research Objectives
What are the quantitative factors that have influenced risk management practices in the E&P industry?	To identify similarities and differences across enterprise size, business area and other identified factors
What are the methods and techniques used in the steps of the risk management process?	To find out about the formal techniques of risk management
How is risk management incorporated into the company's organizational structure?	To inquire the organization of risk management
What are the qualitative factors that have influenced risk management practices in the E&P industry?	To reveal how personal attitude to risk affects approaches to risk management
In which way has the risk management process been linked to the business planning?	To focus on links of risk management with business planning and decision making
At which phases of the project life cycle are risk management techniques utilized?	To examine the handling of single projects with respect to their contribution to the risk situation
How is the interface between single project risk considerations and the risk profile for the entire enterprise developed?	

Table 11: Research Questions with their Objectives

A large amount of detailed work is involved in designing comparative assessment, data gathering, analysis and conclusions of benchmarking. In the design of benchmarking, it is helpful to have a structure. Risk management, in common with other business processes, is a living system. Therefore, risk management benchmarking involves designing a set of comparisons which can be applied to a system. By way of comparison, it is as if we asked "what is the best database?" Although we can examine inputs and outputs from databases in raw numerical terms, such as the amount of data handled in a period of time, this is unlikely to generate a helpful answer about the best database. The correct question is far more difficult to answer, "Which database is best fit for the purpose we need?"[149]

The next step for our benchmarking study will be a thorough consideration of what constitutes comparable organizations. The driving questions are:

- Do we want to learn best practices or see how comparable organizations tackle our sort of risk problems?
- Are we going to learn more from people like us, or from people outside our sector working with different problems?[150]
- Which organizations have structures enabling risk identification and treatment?
- How do we detect best structures, best in class?

[149] Mainelli, M., 1999, P. 2
[150] Mainelli, M., 1999, P. 2

Studies show that the clearer and simpler the objectives are, the better the end-result will be. Therefore, the initial focus should be set on defining significant parameters in order to measure performance. The proposed KPI's for this benchmarking study will be:

- **Inputs**: Number of people involved for establishing a risk register/for identifying risks (quantity), expenditure on risk management(cost),management time spent(time), compliance time and effort (time, quality), external advisors and costs (quantity, cost), frequency of standards used (quantity)
- **Processes**: Risk identification (quality), risk assessment (quality), time between risk identification and treatment (time), documentation (quality, quantity), education (quality)
- **Outputs:** Numbers of risk assessments (quantity), training days (quantity), scale of communications and any other dealing with efficiency (quality), Value at Risk (percentage), how often is risk analysis updated (quantity)?
- **Feed-back**: Looking at measures of effectiveness in measurement and reporting structures (quality),reductions in the cost of risk(percentage), risk reduction (percentage),event and impact comparisons(cost),testing wider awareness in the organization (percentage)
- **Feed-forward**: Risk-based planning
- **Occurred risks**: Severity and frequency of occurred risks (quantity, quality); rate of occurrence of non-identified risks (quantity)
- **Monitoring**: Target and objective setting (quality),communications and briefings(quantity)
- **Reporting**: Rate of reporting to stakeholders (quantity); regularity of database update (quantity); use of lessons learnt for other projects (percentage)

After gathering and analysing the data, the ultimate goal will be to identify best practices and the resulting gap between **OMV** and a best-in-class company.

The working plan therefore was divided in four phases:

- Theoretical preliminary work
- Planning and executing the data collection
- Collecting and analyzing the data
- Evaluating the data.

Here fore, it has been decided to prepare a survey, which will be sent out by Email to experts in risk management within the E&P industry. The questions will be gradually leading to answer the main driving questions given above. The questionnaire will be based on:

- Questions from past surveys such as from PricewaterhouseCoopers, Ferma European Risk Management Benchmarking Survey and others,
- Themes which have been point out by the literature regarding Benchmarking and Risk Management,
- Discussions between the author of this thesis and colleagues, experts and advisors.

Each participant recieved the same instruction with following notices:

- Purpose of the survey

- Responsibles for the survey
- Time needed for answering the questions
- Deadline for submission
- Contact person in case of queries
- Guarantee for anonymity

Question forms such as matrices, semantic differentials, polarity profiles and graphic scales will not be used for this survey because of the complexity and length of these question forms, which could have negative influence on the motivation of the participants.

3.5 Results of the survey

The survey has led to several interesting findings, which we will discuss in the following chapter.

Out of 358 potential participants who were given by a mailing list from the department of economics, 258 were theoretically reachable. A total number of 213 people have at least clicked on the link. From these 213 participants:

- 88 participants have at least answered one question.
- 40 have completed the survey.
- In an average time of 18 minutes.

Therefore, out of the 88 participants:

- 47.7% could have been reached via social media, and
- 52.3% via the official mailing list.

The Email included a pdf version of the complete questionnaire as well as a confidentiality promising to all participants. In case of interest you can find this at the end of this thesis.

The survey was organized with the following structure:

- Questions 1 – 8: General questions. Here we tried to find out some facts about the size of the company and the participant himself/herself.
- Questions 9 – 28: Organization of risk management in the business: responsibilities, structure, knowledge management, tools and methods used.
- Questions 29 – 34: Software related questions.
- Questions 35 – 39: Personal interpretation about actual barriers as well as future trends.

Survey - Questions

Question 1: *Which business area does your company belong to?*

This question was asked in order to get insights on what area of business the company is specialized in, to better cluster the answer provided by each participant. The survey was addressed to professionals in different areas. The sample size of people within the Exploration and Production area was rather high since the focus of this thesis is laid on E&P capital projects. The results corresponded to the sample used.

Exploration	5%
Production	5%
E&P	48%
Integrated	12%
Service	25%
Other	5%
	100%

Table 12: Results of Question 1

Also enough participants came from Integrated and Service companies, as we decided not to neglect their perspectives. Two participants chose to use the "other" option, but only one specified to be working for a gas pipeline company.

Question 2: *Your company/organization is:*

The goal of this question was to get insights on ownership type of the company and its impact on the way they act towards risk management. Due to the significant difference between private and state controlled companies in terms of management, business strategy, valuation methods or legal obligations, it was necessary to.

Private	95%
State Controlled	5%
	100%

Table 13: Results of Question 2

Almost all participants come from a private company. This does not exclude firms which are partly owned by the state.

Question 3: *Is your company quoted on the Stock Exchange?*

We would like to assess the number of participants working for companies quoted on the stock exchange, and understand if stock exchange listed companies manage risk differently than others.

Yes	60%
No	40%

Table 14: Results of Question 3

From the forty participants, 26 actually work for a company quoted on the stock exchange.

Question 4: *In how many countries is your company operating?*

We would like to get a better understanding of the geographical size of the company. By adding up the results of the previous questions, we may acquire a good overview over the general size of the company.

In one country	5%
In 2 to 5 countries	27%
In more than 5 countries	68%

Table 15: Results of Question 4

The results show us almost three quarter of the respondents work for companies present in over 5 countries.

Question 5: *What is your job title?*

It is of crucial importance to understand the responsibility area of the respondent in the company, whether he/she belongs to upper management, works as a university professor or any other profession.

Risk Manager	10%
Chief Risk Manager	0%
Project Manager	45%
Asset Development Manager	3%
Risk Coordinator	3%
CEO	5%
CFO	3%
Other upper management	8%
University Professor	0%
Other	38%

Table 16: Results of Question 5

As this survey was supposed to be directed to professionals in risk management, over half of all respondents have the job title of Project Manager (45%) and Risk Manager (10%). The difficulty while composing the mailing list was to filter out clearly who could be a Risk Manager and who deals with risks and risk management on a regular basis. Therefore, social media was very helpful by offering groups such as "Risk Managers" or "Oil and gas People", where one can ask a special group of people to participate to the survey.

A major group of the participants chose the option "other" (38% - 15 people). They specified to be a:

- "Sr. Consultant"
- "Project Service Manager"
- "Contract Manager"
- "Planner"
- "EHS Supervisor/Manager"
- "Risk Consultant"
- "Risk Specialist"
- "Technical Director"
- "Business Analyst"
- "Business Risk Director"

Some chose not to specify their job title, as we only received 10 open answers.

Question 6: *What is your educational background?*

We want to get insights on the individual´s educational background and its impact on the way each respondent looks into risk management.

Technical	65%
Financial	20%
Law	3%
Other	12%

Table 17: Results of Question 6

As we notice, a great part of the participants have a technical background.

Five participants come from a non mentioned background, and four chose to specify following education:

- "Project Management & IT"
- "Economist/criminologist"
- "Risk Management"
- "Technical & Financial"

Question 7: *Are you a full-time employee in risk management?*

It is important to understand the role of the respondent in his/her company´s risk management system. A lower amount of invested hours may have an impact on the granularity of the company´s risk management. Furthermore it may help us understand whether the respondent has a key role within risk management and deals with the tools and methodologies, or not.

Yes	25%
No	75%

Table 18: Results of Question 7

Only a quarter of all respondents have a full-time job in risk management, therefore dedicate all there time and resources to this purpose.

Question 8: *How many hours per month do you dedicate to risk management?*

The answers resulting from this open question should show us how much time is dedicated to risk management. It is crucial to understand the size of the respondents engagement with risk management. Answers vary from one hour until 180 hours per month:

1-10 hours	47,5%
10-40 hours	37,5%
40-100 hours	7,5%
>100 hours	7,5%

Table 19: Results of Question 8

Question 9: *Does your company have a formal risk management organization for your risk management activities?*

It is important to find out whether the company performs risk management within an allocated risk management organization, or only as part of another greater task. This question aims on assessing the risk managements organizational structure of the respondents company.

Yes	65%
No	35%

Table 20: Results of Question 9

In the survey, 65% have a formal risk management organization, while 35% does not.

Question 10: *Which answer represents your risk policy best?*

To fully understand the company´s profile, it is crucial to comprehend the company´s general approach towards risk. We distinguish between proactive, calculative and reactive policies.

Proactive (working on risks which haven't occurred yet)	48%
Calculative (systems in place to manage risks)	40%
Reactive (perform tasks once a risk turned into an issue)	10%
Other	2%
	100%

Table 21: Results of Question 10

Half of the participant's company's risk policy is being proactive (48%), while 40% are calculative. Calculative structures are strong with managing risks. Only ten percent state that they have are active policy, therefore have a crisis-based thinking. Solutions are developed after problems arise; therefore much time is spent on fighting fires.

Question 11: *Does the organization have early warning indicators in place to alert management of potential risks?*

We would like to assess whether the company has a risk management warning system or not. The answer may help us identify proactivity within the risk management strategy. This question is directly linked to the answer of the previous question, therefore only appears if the participants answered "Proactive" before.

Yes	53%
No	47%
	100%

Table 22: Results of Question 11

Slightly over half of the respondents companies possess early warning indicators in order to achieve a better proactivity of their risk management system.

Question 12: *Please answer the following questions with Yes/No*

Through answering these questions, the respondent give us an insight in how advanced his company is in standardizing risk management. Though the definition of risk may be common to all professionals, it is important to have a single definition in order to provide the same starting point for everybody. Furthermore, the exact definition of roles and responsibilities provides a solid base for efficient risk management.

	Yes	No
Is there a company-wide definition of risk?	77%	23%
Does your company have a handbook for risk management?	68%	32%
Are there well defined roles and responsibilities for your risk management?	75%	25%
Is your risk management system certified?	25%	75%

Table 23: Results of Question 12

We notice, three quarter of the participant's companies have a companywide definition of risk and 68% have a handbook for risk management. Basically the two go more or less hand in hand, since a handbook stands for rules and standards, which should include exact definitions of risk.

75% have well defined roles and responsibilities for risk management and only a quarter has certified risk management systems.

Question 13: *Is your risk management system following an official standard?*

This question only appears when the participant choses to state that the risk management is certified (previous question). It provides us with insights on what standards the companies rely on.

ISO 31000	30%
PMBOK - Project Management Body of Knowledge	30%
COSO - Enterprise Risk Management	20%
National Risk Management Standard	0%
Internal Framework	70%
Other	10%
	160%

Table 24: Results of Question 13

In this case, 10participants were asked to answer this question. The sum of the percentage shares is more than 100% since candidates could choose more than one answer. In most of the cases internal frameworks are combined other standards.

Question 14: *Is risk management linked to business planning?*

The result of this question should show how risk management is linked with business planning, notably how risks are incorporated. Since achieving business goals in an industry (such as the oil and gas industry) stands for managing projects and operations, it is crucial to involve risk management within business planning.

Yes, there is a direct integration of risk figures into the business planning system	58%
Yes, but there is no direct representation of risk figures within the business planning system	27%
No, there is no connection with the business planning system	15%
	100%

Table 25: Results of Question 14

- 58% have a direct integration of risk figures into the business planning system
- 27% have a link, but there is no direct representation of risk figures within the business planning system
- 15% have no connection with the business planning system.

Question 15: *Who is responsible for your project risk management?*

It is important to understand who is involved in decision making within risk management. This may give us better understanding over responsibilities as well as communication between risk management and upper management.

Board of directors	15%
Internal audit	8%
Designated risk manager	13%
CFO	10%
Controlling department	5%
Staff of business units	18%
Project manager	75%
Other	10%
	154%

Table 26: Results of Question 15

By answering this question candidates could choose more than one answer. From the 40 participants, some have chosen to answer several times, which explains why there are 61 answers.

75% state that the Project Manager carries the responsibility for project risk management. Other answers are:

- "Project Director"
- "Planner"
- "Management Team and"
- "Owner of Company"

Question 16: *How often is training provided to the responsibles for risk management?*

The background of this question was to learn more about the amount of trainings provided to people in charge of risk management. Are the responsibles pushed forward to gain a better theoretical knowledge and to enhance their qualifications?

No training provided	13%
Ad-hoc training	35%
Periodic training	35%
I don´t know	13%
Other	4%
	100%

Table 27: Results of Question 16

13% of the answers show us that no training is provided. A notably large part 70 %, offers either ad-hoc training or periodic training.
13% of the participants actually do not know whether training is provided or not. Finally, four percent state via open answers:

- "ISO31000/ISO31010 training – This stands for a training concerning the ISO standards for risk management"
- "during project kickoff "

Question 17: *How are the practices of your risk management disseminated?*

It was essential to check if it is a common practice to use manuals as guidance when performing risk management in the industry? The existence of a manual can lead to a standardization of methods and tools, with exact instructions how to perform tasks.

Risk management manual	45%
General procedural manual	40%
Controlling manual	15%
Other	25%
	125%

Table 28: Results of Question 17

We notice, almost half of the companies (45%) use a risk management manual for their risk management while 40% use a general procedural manual.
Open answers:

- "No given procedures - every project is assessed differently"
- "Seminars"
- "Standard is in progress"
- "No manual"
- "Project management handbook"
- "Not disseminated"
- "No risk management so no dissemination"

Question 18: *Does your company run a risk management system for single projects?*

In order to assess the granularity of a company's risk management system, the first step is to examine how often and under which circumstances a risk management system is run.

Yes, for each project	35%
Yes, but only for some projects	52%
No	13%
	100%

Table 29: Results of Question 18

Approximately a third of the results show us that the companies perform risk management on every single project. Fairly over half state that only some projects are considered for risk management.

But 13% do not have any risk management for single projects.

Question 19: *Which risks do you consider for single projects?*

This question only appeared when a candidate chose "yes" on the previous question. It shows us the most important risk categories which are treated within capital projects in the exploration & production industry.

Legal risks	83%
Design and construction risks/technical risks	91%
Operational risks	83%
Financial risks	91%
Personnel risks	74%
Quality risks	74%
Einvironmental risks	80%
Other	20%

Table 30: Results of Question 19

As several answers were selectable, we notice that all proposed answers have been selected an important number of times. This proves that all risks need to be taken in grand, whilst the most important ones remain financial risks and design and construction risks as well as technical risks.

Other risks appearing in open answers are:

- "HSSE"
- "Reservoir and Production"
- "Business continuity"
- "Schedule risks"

Question 20: *Are your single project risk evaluations integrated into the business planning of your entire business?*

The results of this question show us that 30% integrate always their single project evaluations into the business planning of their entire business. Roughly half do the same, but only for a selected amount of projects. Surprisingly, 13% do not even know the consequences of project risk evaluations in regard to business planning.

Yes, for each project	30%
Yes, but only for some projects	53%
No	5%
I don´t know	12%

Table 31: Results of Question 20

Question 21: *Once a Risk Management process has been completed, is there a documentation of your work such as an update of an existing database, in order to determine best practices for the future?*

This question treats the topic of documentation and how it is performed within the companies. Documentation and capturing lessons learned is a vital pillar for success and improvement.

Yes, in case of an unexpected event	40%
Yes, but only for major projects	20%
Yes, always	15%
No, but we are planning it	15%
No, and we don´t plan it	7%
Other	3%
	100%

Table 32: Results of Question 21

The majority of the answers reveal that the trend is continuing towards documenting, building up databases and planning to do so.
20% is documenting only in case of a major project, neglecting possible lessons learned from smaller projects.
Open answer: "No, remote sites are rarely communicated unless during an investigation". As usual, not all candidates specified after clicking on "other".

Question 22: *Where is information about risks for individual projects recorded?*

This question was put in place in form of an open question, therefore we were able to gather an important amount of information regarding where information is recorded. We would like to find out where risk related information can be found, and how it can be captured and processed efficiently.

Answer	How often	Answer	How often
Partly spreadsheets (MS Excel), partly database	3 x	Manual	1 x
Risk Register	6 x	Tacit knowledge	1 x
RM software tool	1 x	EDV system	1 x
In the HSE manuals	1 x	Information drive	1 x
In a documentation provided to client	1 x	Dedicated portal on company's network	2 x
Primavera Excel EDMS - Data Management System	2 x	Controlling Department	1 x
Easy Risk	1 x	Document System (Sharepoint)	2 x

Unknown, former management team did not have a program in place, current team had not received any training nor improvements from internal sources	1 x	Lessons learnt library	2 x
In the business plan	1 x	Project manager computerize the information into a standard file	1 x
Individual project documentation	5 x	PM Office and Data base Corporate	1 x
Database	4 x	Not recorded	1 x
PIMS	1 x	In the accounting system, SAP and Oracle.	1 x

Table 33: Results of Question 22

Question 23: *Is your risk management system supporting project clustering (forming groups of similar projects with similar risks in order to have reference projects)?*

Project clustering is the grouping of similar projects with similar risks and opportunities. Therefore, it would make sense to have quick access to those reference projects in order to accelerate the process of acquiring knowledge over the related risks.

Yes	35%
No	65%

Table 34: Results of Question 23

Only a minority of 35% does actually perform project clustering.

Question 24: *How are your risks identified and evaluated?*

The size of the team as well as the roles and responsibilities of the individuals involved in risk identification, provide good insight view over the granularity of the risk management system. Assempling teams with individuals from various backgrounds and departments may offer a higher efficiency in identifying and evaluating risks, rather than involving a single business unit.

By management alone	8%
By management together with departments	35%
By internal audit	10%
By controlling department	13%
By workshops with business units	48%
By designated employees of business units	28%
Inquiries by questionnaires or checklists	20%
By project team	75%
Other	5%

Table 35: Results of Question 24

Basically, in three-quarter of the cases, the team responsible for identifying and evaluating risks is the project team. Half of the respondents also state that risks are identified and evaluated within workshops including the business units, therefore the companies try to

gather as much expertise as possible in order to make the best decisions. Another approach is to gather key people of single departments as well as management.

On the other hand, 8% state that only the management is responsible for identification and evaluation of risks.

Answers given within through the open field were:

- "Internal & external stakeholders, depending"
- "Risk is not a word known in the organization"

Question 25: *For the methods used for **risk identification:***

a) How often are they used? Please rate from never (1) to very often (5)

b) How successful are they in achieving a thorough and comprehensive analysis of risk? Please rate from not successful (1) to very successful (5)

	Arithmetic mean	
	Question a	Question b
Brainstorming	4	3,97
Checklists	3,68	3,62
Fault tree analysis	2,54	2,93
Mind map	2,31	2,93
FMEA	3,08	3,52
Ishikawa	2,07	2,53
Brainwriting	1,59	2
Method 635	1,48	2
SWOT	3,68	3,67

Table 36: Results of Question 25

This table combines the rating for the frequency of use with the rating for success for each risk identification method proposed in the survey. Methods with stable and high ratings are considered to being the most preferred within the industry. The rate ranging from 1-5 stands for the arithmetic mean calculated from all the results gathered excluding those who did not have an opinion.

	Brainst.	Check list	Fault T.A.	Mind Map	FMEA	Ishikawa	Brain writing	Method 365	SWOT
Question a	0%	0%	8%	8%	5%	28%	27%	32%	13%
Question b	5%	6%	22%	19%	18%	46%	56%	63%	17%

Table 37: Percentages of "No Opinion

Question 26: *For the methods used for **qualitative risk analysis:***

a) How often are they used? Please rate from never (1) to very often (5)
b) How successful are they in achieving a thorough and comprehensive analysis of risk? Please rate from not successful (1) to very successful (5)

	Arithmetic mean	
	Question a	Question b
Brainstorming	4,03	3,86
Risk matrix	4,03	3,97
Personal & corporate experience	4,34	4,08
Interviewing	3,11	3,61
FMEA	2,89	3,1
Pareto	2,15	2,56
Ishikawa	2,13	2,5
Dependancy map	2,07	2,55
Event tree analysis	2,87	2,85
Cost-utility analysis	3	3,39

Table 38: Results of Question 26

The best results are Brainstorming, Risk Matrix as well as Personal and Corporate experience. Interviewing is used in an average frequency, but is commonly seen as quite successful. Once again, Ishikawa remains one of the least used methods due to low success ratings from the professionals. Furthermore, it remains one of the least known methods, along with Pareto and Dependency Map, as we can see in the table below.

	Brainst	Risk Matr.	Personal & Corp. Exp.	Inter-view	FMEA	Pareto	Ishi-kawa	Depend-ency Map	Event Tree Analysis	Cost Utility Analysis
Ques-tion a	3%	5%	0%	3%	8%	28%	35%	23%	16%	22%
Ques-tion b	5%	5%	3%	14%	16%	47%	50%	41%	25%	34%

Table 39: Percentages of "No Opinion"

Question 27: *For the methods used for **quantitative risk analysis:***

a) How often are they used? Please rate from never (1) to very often (5)
b) How successful are they in achieving a thorough and comprehensive analysis of risk? Please rate from not successful (1) to very successful (5)

	Arithmetic mean	
	Question a	Question b
Brainstorming	3,57	3,66
Risk matrix	3,54	3,9
Exp. Monetary value	3,84	3,97
Break even analysis	3,42	3,63
Scenario analysis	3,58	3,94
Exp. Net present value	3,9	4,09
Risk adjusted discount rate	2,94	3,48
Simulations	3,43	3,86
Portfolio theory	2,46	2,82
Event tree analysis	2,42	2,9
Cost utility analysis	2,53	3,11

Table 40: Results of Question 27

Here, we notice there are several quantitative methods which are considered as highly successful by the participants of this survey. These are once again Brainstorming, the use of a Risk Matrix, Expected Monetary Value, Break Even Analysis, Scenario Analysis, Expected Net Present Value and Simulations such as Monte Carlo Simulations.

	Brainst	Risk Matrix	EMV	Break Even Analysis	Scenario Analysis	Expected NPV	Risk Adj. Disc. Rate	Simul	Portfolio Theory	Event Tree Analysis	Cost Utility An.
Ques a	3%	5%	5%	3%	3%	3%	10%	10%	26%	16%	17%
Ques b	9%	16%	16%	19%	14%	11%	38%	19%	51%	43%	47%

Table 41: Percentages of "No Opinion"

From the table above, we may notice that for the methods given, a good amount of experts have knowledge regarding the usage and success. With a few exceptions, we can generally conclude the fact that professionals are well trained and well kept up to date for the process of quantitative risk analysis.

Question 28: *For the methods used for **risk control and monitoring**:*

a) How often are they used? Please rate from never (1) to very often (5)
b) How successful are they in achieving a thorough and comprehensive analysis of risk? Please rate from not successful (1) to very successful (5)

	Arithmetic mean	
	Question a	Question b
Checklists	3,71	3,66
Risk Matrix	3,91	4,23
Fault tree analysis	2,56	2,85
FMEA	2,88	3,14
Decision tree analysis	2,58	3,13
Event tree analysis	2,34	2,86
Cost utility analysis	2,57	3,19

Table 42: Results of Question 28

For the participants of the survey, the trend is to focus on two methods: using checklists and risk matrixes. These two achieve over-average ratings and can be seen as the two leading methods for risk control and monitoring, as they also are the most successful according to the risk professionals.

	Checklist	Risk Matrix	Fault Tree Analysis	FMEA	Decision Tree Analysis	Event Tree Analysis	Cost Utility Analysis
Question a	5%	8%	11%	13%	5%	16%	19%
Question b	8%	16%	25%	20%	36%	42%	42%

Table 43: Percentages of "No Opinion"

Question 29: *Is any software used to aid risk management in your company?*

In order to proceed with software related questions, such as the satisfactory level and usefulness, we must assess whether companies use any software solutions for risk management.

Yes	65%
No	30%
I don´t know	5%

Table 44: Results of Question 29

The result of this question shows us that 65% of the participant's company uses some kind of software to support the risk management process. Exactly 30 % does not use any risk management software, while 5 percent does not even know whether any software is used or not. The following question will reveal which software is used.

Question 30: If yes, which software packages are used?

In order to get an idea what software is used, this open question helped us gather several names of software solutions which support the risk management process.

Software	How often
Easy risk	8 x
Primavera Risk Analysis	7 x
Crystal Ball	3 x
In-house Software	2 x

Excel	4 x
Active Risk Manager	1 x
OCIS	1 x
PMI	1 x
Simeo	1 x

Table 45: Risk Management software in use

Easy Risk from the Norwegian company Det Norske Veritas, as well as Primavera Risk Analysis from Oracle are the most common software tools used.

Question 31: *Do you think that this/these tool/s have increased the efficiency of risk management procedures in your company?*

It is important to gather feedback from the respondents, regarding their personal thoughts about the impact of used tools on risk management.

Yes	65%
No	20%
I don´t know	15%

Table 46: Results of Question 31

Over half of the participants agree with the fact that the software tools, which have been discussed in the previous questions, have increased the efficiency of risk management procedures. One fifth states that no increase in efficiency can be noticed.

Question 32: *Please rank following aspects (1-5, 5 being the most important):*

We would like to gain a better understanding over the general satisfaction and importance of the software used. The respondents might be dealing with these tools on a regular basis and may give us useful insights regarding these crucial aspects.

	1	2	3	4	5
Importance of using a software tool for risk management	12%	12%	8%	30%	38%
Your satisfaction with your current risk management software	12%	15%	15%	54%	4%

Table 47: Results of Question 32

Basically, risk professionals agree with the fact that using a software tool for risk management is of high importance. A majority of the participants give good ratings for the importance and therefore show us how significant it is nowadays to acquire state of the art software. The next question will show us what aspects are of high value

Question 33: *Please rate following aspects considering your satisfaction level about your current risk management software: (1-5, 5 being the best):*

When evaluating and assessing any software, many criteria must be considered. Some are not as significant as others, but remain of importance.

	1	2	3	4	5
Time	8%	25%	33%	21%	13%
Adaptability to any risk types	8%	33%	17%	29%	13%
User-friendliness	20%	25%	13%	25%	17%
Data Export	8%	21%	33%	21%	17%
User access according to area of responsibility	4%	29%	25%	29%	13%
Built in alerting mechanisms	9%	27%	23%	27%	14%
Other	29%	29%	14%	14%	14%

Table 48: Results of Question 33

Via the results of this question, we can identify which aspects fulfill the respondent's satisfaction level, and which aspects need revision/improvement. The aspects named in this question have been undergone a rating showing how satisfied the risk professionals were about their current risk management software. The other aspects, which have been given by the respondents via the open question, were:

- "Compatibility with excel"
- "Further calculation and consideration in time and costs"
- "Process safety"
- "Aggregating risks and uncertainties"

Question 34: *Please rank following aspect (1-5, 5 being the most important):*

The personal feedback of each respondent regarding the importance for using a software tool for risk management is of great value. It enables an understanding about the mindset of the risk professionals, and can help identifying possible improvements.

	1	2	3	4	5
Importance of using a software tool for risk management	25%	8%	42%	17%	8%

Table 49: Results of Question 34

A quarter of the respondents state that a software tool is not important at all for risk management. The biggest part has neutral opinion about the importance; therefore we cannot really notice any tendency.

Question 35: *How satisfied are you with following aspects within your company's Risk Management, on a five point scale with 5 being "the most satisfied"?*

We would like to understand the big picture of the satisfaction with current risk management processes in the companies. Therefore, the risk professionals were asked to rank their satisfaction level with the most important aspects of risk management. The risk professionals are mostly unsatisfied with three major topics within their company's Risk Management:

- Database handling: the use of knowledge management, handling with data from previous projects.
- Top-down flow of information: the flow of information from top management to the lower structures such as risk managers.
- Use of lessons learnt: the learnings from previous projects, companywide best practices.

General satisfaction was mostly achieved for:

- Choice of methods used: which methods are used for a corresponding stage of the risk management process?
- Cross disciplinary involvement: finding a good mix between all business units as well as people with different background, function within the company and experience.

Other answers were:

- "Incorporating risk analysis with decision analysis"
- "Tracking long term plant reliability"

	1	2	3	4	5
Choice of methods used	8%	10%	38%	36%	8%
Frequency of risk relevant procedures	8%	25%	31%	28%	8%
Cross disciplinary involvement	10%	26%	23%	28%	13%
Reporting	10%	18%	34%	28%	10%

Database handling	18%	25%	31%	21%	5%
Bottom-up flow of information	13%	18%	31%	28%	10%
Top-down flow of information	15%	28%	36%	13%	8%
Use of lessons learnt	16%	29%	21%	18%	16%
Other	0%	40%	0%	20%	40%

Table 50: Results of Question 35

Question 36: *Please answer following questions regarding training:*

What is the general opinion about the need for training? Do the professionals believe they are well trained, and therefore do not require any additional trainings provided by their company?

	Yes	No	I don´t know
Do you think it is necessary for companies to develop specific training to help individuals and teams discuss risk and uncertainty?	90%	5%	5%
Has your company developed any such training or vocabulary?	55%	40%	5%

Table 51: Results of Question 36

Almost all participants agree with the fact that specific training should be developed in order to help individuals and teams discuss risk and uncertainty. This aspect is seen as very important, although only slightly above half of the companies offer the specific trainings.

Question 37: *What areas of improvement does the organization need to focus on to strengthen its risk management capabilities?*

We would like to gain a better understanding over the improvement needs. In order to strengthen the risk management capabilities, improvements must be made. The respondents can provide a critical input, therefore they were asked to choose the three most important areas of improvement, from their personal point of view.

Align risk management and business strategy	58%
Acquire a more comprehensive view of risk	38%
Redefine risk ownership, processes and structure	35%
Improve coordination between multiple risk functions	25%
Improve risk communication	55%
Leverage technology and tools	18%
Standardize risk processes, methods and tools	35%

Streamline risk reporting	18%
Promote a risk culture	53%
Outsource certain risk functions	5%
Other	3%

Table 52: Results of Question 37

The three most clicked choices were:

- Aligning risk management and business strategy
- Improve risk communication
- Promote risk culture

Question 38: *What do you see as the greatest barriers to the effective management of risk in your organization?*

It is of great importance to understand the challenges the companies face when it comes to managing risks and opportunities. These aspects will most probably be the greatest challenges in risk management for the near future. The three most stated options were:

- Lack of time and resources
- Lack of support from management
- Lack of skills for effective risk management

The answers given via the open answer option were:

- "None since we are a consulting company"
- "External drivers to take risk"

Lack of time & resources	43%
Difficulty in identifying& assessing risks	23%
Lines of responsibility for managing risk not sufficiently clear	18%
Threat from unknown, unforeseeable risks	15%
Lack of support from management	33%
Difficulty harmonizing risk appetite across business units and geographies	18%
Regulatory complexity	8%
Lack of available data	8%
Lack of skills for effective risk management	38%
Lack of general understanding what project risk management is about	28%
Effort seen as too high for the benefit it gives	20%
Other	8%

Table 53: Results of Question 38

Question 39: *What changes do you expect to your organization's investment in the following aspects of risk management over the next three years?*

Here, we want to understand what can be expected from the professionals in the near future, in order to provide recommendations to make the right investments. The

companies will have to readjust and optimize certain aspects. Once again, three answers were required, which could give an idea of future trends regarding risk management.

Improving data quality& reporting	45%
Strengthening risk assessmentprocess	43%
Management training in risk management	35%
Analytics and qualification	28%
Framework development	10%
Board training in risk management	20%
Setting risk roles & responsibilities	38%
Embedding corporate strategies in regional businesses	18%
Other	10%

Table 54: Results of Question 39

Here the top three answers were:

- Improving data quality and reporting
- Strengthening risk assessment process

Setting risk roles and responsibilities

4 Comparison between OMV and the Industry

OMV's contribution to this survey can be seen as significant, as we notice that 20 percent of the total answers come from risk/project professionals from OMV. Most of them deal with risks on a regular basis – as the job titles are Risk Manager, Project Manager, Risk Coordinator or Contract Manager *(Quest.5)*. All OMV professionals have a technical background while the survey shows that there can be a small minority with a financial, law or another background (*Quest.6)*.

It is important to find out whether the company performs risk management within an allocated risk management organization, or only as part of another greater task. By having a formal risk management organization, the company should have a risk management framework which could be in form of a standard. OMV professionals agree on the fact that there is a formal risk management organization for OMV's risk management activities (*Quest.9*), but do not find an unanimous agreement on its risk policy, whether it is proactive, reactive or calculative (*Quest.10*) although the internal risk management standard says "OMV takes a proactive project risk management approach through following actions:

- Establish and maintain management commitment to performing risk management on all capital projects.
- Start the risk management process early in the project lifecycle and across the project portfolio.
- Include all key stakeholders and disciplines in the process.
- Identify, assess and prioritize all key project risks.
- Take account of opportunities explicitly – do not only focus on threats.
- Evaluate and update project risks and risk treatments regularly.
- Communicate project risk progress and changes to all key stakeholders (including project owner and steering committee).
- Capture lessons learned and share project best practices. "

By being proactive, a risk management policy is to avoid risks occurring by all means. The focus can be set on installing alerting mechanisms as well as having a low risk tolerance. Proactive thinking involves foresight, therefore anticipates future changes or problems. As shown in the Front End Loading diagram (chapter 2.4 – figure 3), treating risks the earliest possible may save a lot of money and may be the decisive point in turning a project profitable or not. Being calculative would involve the assessment of probabilities for certain events. The results of the survey show us it may not be unusual that a company tends to have a calculative risk policy, while the industry-wide trend is a proactive way of treating risks.

For all the respondents from OMV which have chosen to answer "proactive" on the previous question, their company has early warning indicators in place to alert their management of potential risks (*Quest.11*). An early warning indicator can be set in place, in order to alert the responsible in case of a deviation from normal values. It gives a clear image of the links between performance and risks - driving risk management through specifically derived performance indicators, focused on the causes of key risks. Risks are then monitored with the focus on measuring the causes and drivers, rather than lag indicators describing the symptoms or impacts. This provides a framework for early

warning of future problems. In OMV´s case such measures exist, leading to an advantage over other companies.

All OMV professionals state that there is a companywide definition of risk as well as a definition of roles and responsibilities *(Quest.12)*, which is written down in the OMV Risk Management Standard – this has been discussed in the first chapters of this work. The survey reveals that the main responsible for project risk management is the Project Manager, who supervises all tasks and processes within a project *(Quest.15)*. Almost 40 percent of the OMV participants state as well that a designated Risk Manager may share the responsibility with the Project Manager. The main difference between OMV and the industry lies within a higher level of responsibility for the board of directors as well as the staff of business units of companies not related to OMV.

The majority agrees that their risk management system does not follow single official standards such as ISO 31000 or PMI *(Quest.13)*; instead they let us believe that the system is inspired by several official standards. OMV follows the industry-wide standard by creating its own internal framework which is based on the two major standards ISO 31000:2009 and PMBOK 4th edition. Therefore no difference can be observed.

It can be observed that all risk professionals from OMV agree on the fact that risk management within their company is linked to business planning. We must say that in small firms, business planning is performed in a more or less weak way. Therefore, a direct link with risk management is very unlikely to exist. On the other hand, larger companies carry out a direct integration of risks into the business planning. They associate the identified risks with their values to the corresponding positions in the business planning. In order to quantify the risks, quantitative risk management tools such as the Monte Carlo simulation or sensitivity analysis can be used. Nevertheless, we notice that a quarter of the OMV professionals states that there is no direct representation of risk figures within the business planning system while the rest confirms the direct integration (*Quest.14*). Compared to the industry, OMV has a small advantage due to the fact that all of the professionals believe that business planning is linked to risk management in one way or another.

The survey proves that OMV does not conduct risk management for each single project *(Quest.18)*. It is regulated in OMV´s project management standard that project risk management must be performed for all capital projects. These usually have a minimum investment of 20 Million $. For the rest of the industry, approximately a third of the results show us that the companies perform risk management on every single project. Fairly over half state that only some projects are considered for risk management. Projects may significantly differ in size and cost. Performing risk management on a small project may not be economical or resources may not be available, which explains why the trend is to not perform risk management on each single project.

It is unanimously clear that all risks are considered for single projects. Legal, design and construction, operational, financial, personnel, quality and environmental risks share the same importance for an OMV professional, and can therefore not be treated differently during a project *(Quest.19)*. We may notice a slight preference of two risk categories by the rest of the industry: Technical risks and financial risks. Once again, these are only small tendencies, it should not be neglected that all risk categories share a high importance for all risk professionals within the E&P industry.

When it comes to documentation, it is not clear how OMV behaves. Some agree with the fact that there is always a documentation of the work, such as an update of an existing database, while some believe that it is only done for a selected amount of projects. At the

same time, some believe that there is no such documentation neither a database, but state that such measures are certainly planned in the future (*Quest.21*). Therefore, we cannot really identify the actual behavior regarding documentation at OMV, neither regarding project clustering (*Quest.23*). Nevertheless, OMV´s risk management standard regulates the responsibility of the designated risk coordinator as following: "[…] retrieves lessons learned from other projects and captures lessons learned from the project […]". Therefore we notice a regulated responsibility towards documentation, which can be seen as positive. The majority of the answers which are not from OMV professionals reveal that the industry-trend is continuing towards documenting, building up databases and planning to do so. Gathering all the knowledge is nowadays a key element for success. The trend could one day lead to building advanced databases, probably intelligent databases able to determine similarities within several projects and able to filter out key data.
Approximately 60% state that OMV's risk management system supports project clustering (therefore forming groups of similar projects with similar risks in order to have reference projects). This could actually facilitate the search within a database. Like this, responsibilities as well as expertise can be governed in a more effective way than with a big range database. Compared to the rest of the industry, the results are to OMV´s advantage, as only 35% of the industry-wide professionals say that project clustering exists within their project risk management system. Three different softwares are used for the purpose of keeping a database (*Quest.22*):

- Excel
- Primavera
- Easyrisk

We learn that the OMV respondents are not very positive about top down flow of information as well as database handling, therefore giving medium ratings for these topics (average of 3.1 for top down flow of information and 3.25 for database handling)*(Quest.35)*. The choice of methods used as well as the frequency of risk relevant procedures receives the best ratings (average of 3.8 and 3.9) *(Quest.35)*. These results follow the ratings given by the rest of the respondents from the E&P industry. The same topics have been selected by them, which leads to the conclusion that these topics need general revision as well as the eventual implementation of new structures. New knowledge management software could be a good first impulse in order to make data and best practices available for everybody within a business unit, as well as making communication easier between the different hierarchical layers of a company.

When it comes to the actual task of performing risk management, all OMV risk professionals agree that the project team is mainly in charge of identifying as well as of evaluating risks *(Quest.24)*. Other popular answer options were:

- By management together with departments
- By workshops with business units

This correlates with the answers coming from the rest of the industry, where we can find similar responses. The industry wide trend is clearly to put the responsibility into the project team´s hands, and trying to gather as much expertise as possible in order to make the best decisions.

Methods used during Risk Management

Within the industry, the most popular methods used regarding risk identification are Brainstorming (which is used most of the time and is perceived as being the most successful),

Checklists, FMEA and SWOT *(Quest.25))*. We identify the fact that some methods are commonly better known than others. In our case, "no opinion" mostly stands for the fact that one either does not know the method, or is not involved in the process of risk identification and therefore cannot give further information due to a lack of competences. Methods such as brainstorming and checklists are well known, commonly used, and are very efficient, whereas brain writing and method 365 remain unknown in many of the cases and do not have a high success rating. Within OMV, three methods are dominating for risk identification:

- Risk Register
- Brainstorming during risk workshops
- Risk Breakdown Structure: a structured and organized method to present project risks in a hierarchical manner and to demonstrate most likely risk sources. The most commonly used RBS for industrial projects in oil & gas is TECOP. It provides a better understanding in risk exposure types, dependencies between project risks, root causality of project risks, correlations between project risks and overall project risk.

Regarding qualitative risk analysis, the most common methods used within OMV are once again Brainstorming, Risk Matrix, Personal and Corporate Experience as well as Interviewing *(Quest.25)*. At this stage, following objectives are of main importance:

- Cost/benefit: maximize value for OMV
- Meeting the schedule
- Production targets
- Ultimate recovery
- HSSE integration
- Community, government, reputation and media
- Legal and regulatory compliance

Industry as well as OMV has the same needs and requirements for their qualitative risk management approach, therefore we find great similarities in the usage of methods.

The next step following qualitative risk analysis is the quantitative approach. Here, Brainstorming is again one of the top rated methods, followed by Risk Matrix, EMV, Scenario Analysis and last but not least Simulations such as the Monte Carlo Simulation *(Quest.27)*. Especially Scenario Analysis has achieved great ratings amongst the OMV professionals, in comparison to its results coming from the industry. Furthermore, OMV points out that the responsibles should remain alert to the dangers of relying on mathematical techniques for risk analysis and making assumptions that may be false about their precision and reliability. Qualitative approaches using expert judgment can be more adequate in certain cases.

The last step of the Risk Management Process is regarded as risk control and monitoring. The best rated methods are Checklists, Risk Matrix and Decision Tree Analysis *(Quest.28)*. These methods are also the main methods chosen by the respondents of the industry.

Later on in the survey, we learn that the respondents are generally satisfied with the choice of methods used, as well as the amount of times *(Quest.35)*. We notice that in comparison with the industry, OMV uses industry-wide practices regarding the methods used within the risk management process.

In order to perform Project Risk Management, OMV professionals currently use several software packages aiming to support the methods and tasks discussed before *(Quest.29 and 30)*. These packages are:

- Active Risk Manager
- EasyRisk
- Crystal Ball
- Primavera

The survey reveals that firms with proactive orientation increasingly take advantage of in-house software for risk management purposes.

A quarter of the OMV professionals does not believe that these tools have increased the efficiency of risk management procedures, while 62% do believe in the positive effects of these software packages. The rest does not believe that any effect has taken place, positive or negative *(Quest.31)*. In comparison to the rest of the industry, we notice that the people in OMV tend to be slightly less positive about the efficiency of their risk management software.

We notice, when it comes to transferring information, that there is a higher satisfaction with the flow from bottom to up then from top to down, therefore leading to average ratings for reporting *(Quest.35)*. This is a topic which generally leads to unsatisfaction within the entire industry, and requires an industry-wide development of action plans to enhance top-down reporting. We notice a slight advantage on OMV´s side regarding database handling as well as the use of lessons learnt. Nevertheless, these topics need general revision as well as the eventual implementation of new structures. New knowledge management software could be a good first impulse in order to make data and best practices available for everybody within a business unit.

The respondents are very satisfied with the amount as well as the quality of trainings offered by OMV regarding risk management, since they see this topic as being very important so that individuals and teams can discuss risk and uncertainty *(Quest.36)*. This general way of thinking is shared by the rest of the industry, and should not be let out of sight.

Area of improvement/Future

The people involved in risk management within OMV see two great challenges for the near future, in order to strengthen its risk management capabilities *(Quest.37)*:

- To align risk management and business strategy
- To promote a risk culture

These two topics were chosen by 88% of the respondents and can therefore be seen as areas of improvement for the future.

We notice three main barriers to an effective management of risk in their organization:

- Lack of time and resources
- Lines of responsibility for managing risk is not sufficiently clear
- Lack of skill for effective risk management.

In all three cases, 50% of all respondents believed that each listed point was a main barrier *(Quest.38)*.

In order to make efficient changes in the near future, 63% of the OMV risk professionals hope that their company will improve the risk management structures and the quality of management training for risk management *(Quest.39)*.

To following Figure summarises the comparison between OMV and the Industry. (Fig.17)

	Industry	**OMV**
Strategy	• **Mainly Proactive** • Lower linkage of RM with business planning • **RM process only for selected projects (probably similar approach as OMV)**	• **Mainly Proactive** • Higher involvement of RM in business planning • **RM process mainly for cap. projects (>20M USD)**
Standardisation	• **Companywide definitions** • Definition of roles & responsibilities good but can be improved • Internal RM standard based on international standards	• **Companywide definitions** • Well defined roles & responsibilities in theory but not efficient in practice – confusions • RM standard based on ISO 31000&PMI
Communication	• Poor results with Bottom-up • Same for Top-down	• Very good Bottom-up • Top-Down acceptable (but questionable)
Methods	• **Methods used in a similar frequency for Industry & OMV** • Risk professionals see room for improvement regarding choice of methods	• **Methods used in a similar frequency for Industry & OMV** • Risk professionals satisfied with methods used
Software	• **Easyrisk** • Primavera • Crystal Ball • **Excel**	• **Mainly Easyrisk** • **Excel**
Data Management	• Mostly for large projects & In case of unexpected events • Room for improvement for	• Confusion whether documentation always takes place or not

	use of lessons learnt	• Satisfaction with use of lessons learnt

Fig.17: Comparison Industry - OMV

5 Conclusion

This final part will combine key deliveries of the literature with those from the survey. In order to summarize these key findings, the author will provide recommendations for a risk management process, which will be defined via its critical success factors. The recommendations will not focus on frameworks and methods, as excellent standards already exist, but will focus more on a strategic approach, dealing with the mindset of the risk management team. Companies aiming for an industry wide leadership status in project risk management should behave similarly to the following guidelines.

In generall, project risk management should offer following attributes:

- Risk management must be an organized, continuous task.
- Good internal and external communication: Top-down, bottom-up and company-third party communication.
- Risk management has to be included & aligned within the project management.
- Risk management has to be communicated, understood and respected by all stakeholders.
- The effort must be aligned with the risk. The effort must be economically as well as technically reasonable in alignment with the threats and opportunities.

During the planning phase, therefore when the risk management plan is constructed, key objectives are to build a strategy for the entire risk management process, decide how execution will take place and manage a clean alignment with all other project management tasks. Therefore, three critical success factors can be identified:

- The determination of all barriers which may oppose to a successful risk management process. Barriers, as we have seen in the survey, may be the lack of time and resources, the lack of support from management, such as the lack of available data.
- Build on all stakeholder´s skills and experience. The more knowledge available, the higher the chance of success will be. Therefore, the higher the percentage of cross disciplinary involvement, the more knowledge and expertise will be available.
- Respect policies, practices and company objectives (short-term, mid-term and long-term).

After the planning phase, the first real action phase, also known as risk identification, begins. Effectiveness plays a big role, as it is of great importance to identify as many project relevant risks as possible. Here, several critical success factors can be found:

- Early identification
- Regular identification
- Ad-hoc entries
- Comprehensive identification
- Explicit identification of opportunities
- Multiple perspectives
- Risks linked to project objectives

- Complete risk statement
- Ownership and level of detail
- Objectivity[151]

The following step is the risk analysis phase. This is divided in two stages: qualitative and quantitative risk analysis. Qualitative risk analysis: this phase should consist of the assessment and evaluation of single project risks. After doing so, risks can be ranked and prioritized in order to have a certain order for the following steps. Quantitative risk analysis: this phase provides estimations in numerical values. Here, an overall effect on the project´s objectives is quantified. Results such as probabilities of success in achieving objectives can be expected. For qualitative and quantitative risk analysis, four major points are critical to success:

- Consistent definitions: companywide definitions in order to have consistent understanding of vocabularies
- Gather all kind of information regarding the single risks. Therefore, cross disciplinary involvement may play a role again, but also databases.
- Use a predetermined approach such as impact vs. probability or simulations.
- Perform this task continuously with the possibility to refresh risk-relevant data & information.

Risk response, risk control as well as monitoring are the last step of this continuous process. Concernig this step following points must be observed:

- Roles & responsibilities must be clearly attributed. Once a risk disappears from the radar, clear ownership must show who is responsible in case new situations may require a new approach to the treated risk.
- Communication with all stakeholders in order to discuss the following actions.
- Define timeframe for resulting actions in order to align with other project management disciplines. As mentioned earlier, project management and risk management must go hand in hand in order to be as efficient as possible.
- Provide and allocate resources for all necessary responses while respecting economical and technical boarders.
- Respect company policies, project objectives and requirements of the stakeholders.
- Never neglect opportunities. These may be the reason a project turns economical or not.
- Direct integration of risk monitoring & control into project monitoring & control.
- Keep track of conditions which could trigger risks. Changing environments create new situations which could trigger a treated risk. As mentioned, defined responsibilities ensure that no risk should be entirely forgotten once it disappears from the radar.

[151] OMV Austria Risk Mgmt Standard, P. 7

- Risk should always be a topic on every status meeting agenda. All stakeholders have to be aware of the importance of risk management.

This thesis studied the formal techniques of risk management in all phases; investigated the organization of risk management as well as responsibilities, examined how projects are handled, detected the main barriers in implementing an effective risk management system. For achieving this personal insight view as well as professional expertise of the survey participants was essential. By combining the theoretical with the practical input allowed understanding how state of the art risk management has to be performed. A comparison between industry wide and OMV practice clarified that only minor improvements are needed. Finally the success factors and recommendations on how companies/organizations may improve their project risk management practice are provided.

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