Open University Cyprus **Hellenic *Open University***

Master's join degree/post graduate Programme
Enterprise Risk Management (ERM)

MASTER THESIS

Risk Management Of Large-scale Operations: The Case Of Hydrocarbon Exploration In Cyprus

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Supervisor
Dr.Antonis Targoutzidis

May 2020

Open University Cyprus Hellenic *Open University*

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Summary

The exploration for hydrocarbons in the Exclusive Economic Zone of Cyprus is a subject that is dominating the public conversation in Cyprus the last decade. Especially after the economic crisis of 2013, the exploitation of potential hydrocarbon reserves is seen as a solution for the long term economic development of the island.

Oil and Gas is an inherently risky industry where Risk Management is imperative for optimising the decision making process which maximise the probabilities of the project success.

Environmental disasters such as the Deepwater Horizon on 2010 in the Gulf of Mexico and the crash of the global oil prices we are witnessing the last two months emphasize why the Republic of Cyprus should have in place a comprehensive Risk Management process for the hydrocarbon exploration project.

This master dissertation will present the theory of risk, uncertainty, risk management and it will then present the basic concepts of some of the most popular risk management standards and frameworks.

A synopsis of the efforts that the Republic of Cyprus have made so far in it's pursue for exploiting the hydrocarbons in its EEZ. Those efforts include the bilateral and international agreements that have been signed with other countries and oil and gas companies. Also there is a brief presentation of the most important legislations that regulates the hydrocarbon activities in the Republic of Cyprus.

With the use of the IRGC Framework this master dissertation attempts to identify, analyse, evaluate and manage the risks for the Republic of Cyprus during the hydrocarbon exploration project. The Risk Management proposed includes a pre-assessment stage, an appraisal stage, a characterization and evaluation stage, management stage and the cross cutting aspects such as communication and stakeholders engagement.

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Chapter 1
Introduction

The project of hydrocarbon exploration is very large compared to Cyprus size and economy. With a GDP of 20.7b€ (CyStat 2018) and a population of 864.000 (CyStat 2017) the potential impact that this project can have to the economy and the people of the island is extremely significant. A risk management research is necessary because the current turbulence in the energy markets with growing tensions among major oil producers, the increasing pressure for immediate actions against the climate change which is turning to major environmental crisis, the unresolved Cyprus problem, and Turkey's claims in the East Mediterranean region makes the whole hydrocarbon exploration project a high-risk project.

The current Master Dissertation will focus on what are the risks that the Republic of Cyprus faces and how the use of well-established Risk Management Standards and Frameworks could be beneficial for improving Risk Management.

1.1 Objectives

The aim of the master dissertation is to elaborate on Risk Management and relevant Risk Management standards especially regarding its importance in large scale operations and to analyse on how Risk Management is been implemented in the case of Cyprus hydrocarbon exploration project.

It also aims to present a complete risk analysis including identification and assessment of risks including proposed risk communication and risk treatment strategies for the project from the Republic of Cyprus perspective.

1.2 Research Questions

This master dissertation purpose is to investigate what are the plans and structures that the Republic of Cyprus has in place in respect of management of risk. How the application of risk management standards can provide a useful guidance for a proper risk management to the Republic of Cyprus regarding large-scale operations. What are the risks for the Republic in respect of the hydrocarbon exploration in its EEZ and how significant are those risks and what strategies should Cyprus follow for risk communication and risk treatment?

Chapter 2

Theoretical Background

This chapter will try to establish the basic concepts that will be used throughout the paper. It will explore the meaning of the terms risk, uncertainty, project, project management and risk management.

2.1 Risk and Uncertainty

Every decision includes a certain risk. From the moment that the outcome of an action is uncertain the decision maker must take into consideration the risk. Risk and uncertainty are ever present in everyday life. "*Risk has to be understood as a permanent companion of everyday life*" (Renn, 2010)

As proposed by Pritchard in 2015 "Uncertainty considers only the event and where probability is completely unknown" while "risk is a situation where an event may happen and the frequency of occurrence can be evaluated on a probability distribution of past occurrence or environmental considerations" (Pritchard, 2015)

In risk literature a plethora of definitions were proposed in order to define risk. There are the definitions that are based on probabilities and expected values and others that define risk through events, consequences and uncertainty.

Some of the proposed definitions that are based on probabilities and expected values are:

a) "*Risk is a measure of the probability and severity of adverse effects*"(Lowrance, 1976)
b) " *Risk is equal to the triplet* (s_i, p_i, c_i) *where* s_i *is the* i^{th} *scenario,* p_i *the probability of that scenario and* c_i *is the consequence of the* i^{th} *scenario,* $i=1,2,\ldots,$*)"* (Kaplan, 1981)
c) "*Risk equals the expected disutility*" (Campbell, 2005)
d) "*Risk equal the expected loss* "(Willis, 2007)

Some of the definitions that were proposed and are based on uncertainty and events are:

a) "*Risk is a situation or event where something of human value (including humans themselves) is at stake and where outcome is uncertain*" (Rosa, 1998)
b) "*Risk is an uncertain event or condition that if it occurs, has a positive or negative effect on one or more projects*" (A guide to the project management body of knowledge (PMBOK guide), 2017)
c) "*Risk is an uncertain consequence of an event or an activity with respect of something that humans value"* (Ortwin Renn, 2005)

In Enterprise Risk Management we have to evaluate risk as involving both positive and negative outcomes. The International Standard Organisation defines risk as the "Effect on uncertainty on objectives" ISO 31000:2018 (International Standard Organisation). With this definition ISO recognize that the decision maker must take into consideration that the outcome can have a positive or a negative effect.

2.2 Project

Again in literature there are many definitions of what is a project. Cambridge dictionary defines projects as "a piece of planned work or an activity that is finished over a period of time and intended to achieve a particular purpose" (Cambridge Dictionary)

The Project Management Institute defines it as "A project is a temporary endeavor undertaken to create a unique product, service, or result." (A guide to the project management body of knowledge (PMBOK guide), 2017)

ISO 21500 defines project as "a unique set of processes consisting of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective"

As we can notice, irrespective of the differences in the choosing of words in the above definitions they all include two characteristics a) a project has a definite period, meaning there is a beginning and an end and b) every project has a unique outcome. A project may include elements that are repetitive in nature but each project is undertaken in order to achieve a specific and unique goal.

A project may include, but not limited to: (PMI 2017)

1) Development of a new pharmaceutical compound
2) Merge of two organizations
3) An improvement of a business process
4) Exploring for oil and gas in a region
5) Construction of a building

2.3 Project Management

Project Management is defined in PMBOK Guide (6th edition) as "the application of knowledge, skills, tools and techniques to project activities to meet the project requirements"

For successful Project Management there are various areas of expertise that are needed. PMBOK Guide identifies the following 10 areas:

1) Project Integration Management
2) Project Scope Management
3) Project Cost Management
4) Project Quality Management
5) Project Resource Management
6) Project Communications Management
7) Project Risk Management
8) Project Procurement Management
9) Project Stakeholder Management

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	Planning Process Group	Executing Process Group	Monitoring and Controlling Process Group	Closing Process Group
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work 4.4 Manage Project Knowledge	4.5 Monitor and Control Project Work 4.6 Perform Integrated Change Control	4.7 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Schedule Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Durations 6.5 Develop Schedule		6.6 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Manage Quality	8.3 Control Quality	
9. Project Resource Management		9.1 Plan Resource Management 9.2 Estimate Activity Resources	9.3 Acquire Resources 9.4 Develop Team 9.5 Manage Team	9.6 Control Resources	
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Monitor Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses	11.6 Implement Risk Responses	11.7 Monitor Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Engagement	13.3 Manage Stakeholder Engagement	13.4 Monitor Stakeholder Engagement	

Table 1. Project Management Process and Knowledge Area Mapping. Source: PMBOK Guide (6th edition)

In the table above it is shown on which stage each of the above area of knowledge will be used on a project management process.

This paper is concentrated on the Project Risk Management area of knowledge. In order for a project to be successful, risk management should be a continuance process during the planning, executing, monitoring and controlling phase of the project

2.4 Risk Management

Enterprise Risk Management approach risk management in a coordinated way and takes into consideration operational and strategic risks rather than been focused only on financial risks (McShane, 2011)

The Association for Project Management defines risk management as "the process that allows individual risk events and overall risk to be understood and managed proactively, optimizing success by minimizing threats and maximizing opportunities" (Association for Project Management)

J.Hampton defines Enterprise Risk Management as *"the process of identifying major risk that confront an organisation, forecasting the significance of those risk in business process, addressing the risk in a systematic and coordinated plan, implementing the plan and holding key individuals responsible for managing critical risks"* (Hampton, 2015). In his definition the Risk Management we notice two crucial characteristics of Risk Management, first that Risk Management must be done in a systematic way and second that for every risk that was deemed significant and should be managed an individual must be responsible and therefore accountable.

The Committee of the Sponsoring Organisation of the Treadway Commission (COSO) defines ERM as "*Enterprise Risk Management is a process, effected by an entity's Board Of Directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives"*

2.5 Risk Management Frameworks

In Risk Management literature there are many proposed perceptions of how risk management should be implemented.

1) COSO ERM -Integrated Framework (COSO, 2004)
2) International Standards Organisation as analysed in ISO31000:2018
3) Project Management Institute – Project Risk Management
4) IRGC Risk Management Framework

2.5.1 COSO ERM -Integrated Framework

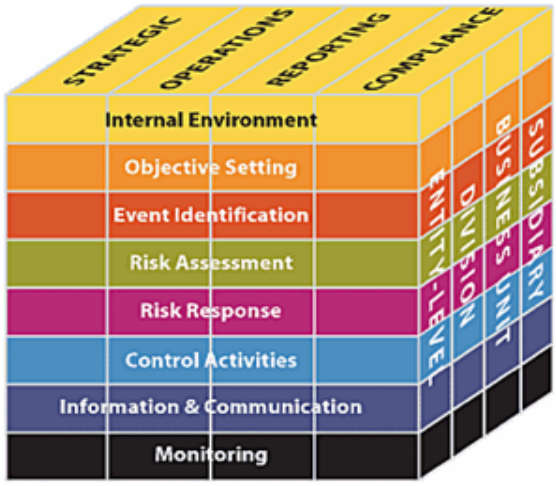

Figure 1. COSO ERM -Integrated Framework (COSO, 2004)

COSO Framework establishes the need that an Enterprise Risk Management Framework must be structured and applied at every level of the organisation that it will promote organizations objectives. The objectives can be seen in the top side of the cube.

- Strategic objectives are the high level goals that an organisation set to achieve its mission.
- Operation objectives are the use of the organizations resources in the most effective and efficient way.
- Reporting objectives are the preparation of reliable financial and operating reports.
- Compliance objective is the effort that an organisation is in compliance with all relevant laws and regulations.

On the other side of the cube we can see the areas were the compliance with COSO standards should be measured.

Internal environment – How an organisation perceives risks and how those risks are addressed?

Objective Setting – The process of setting objectives that support organisations mission while been consistent with its risk appetite.

Event Identification – How an organisation identifies risks and opportunities

Risk assessment – How an organisation analyse the identified risks in order to determine how they should be managed.

Risk Response – How effective are those identified risks been managed by avoiding, accepting, reducing or sharing them.

Control activities – The procedures and policies that an organisation has established for effective risk management.

Information and Communication – How quality information is generated or obtained and how it is shared within the organisation and abroad.

Monitoring – How risk management is evaluated and modified if necessary to improve its effectiveness.

2.5.2 ISO31000:2018

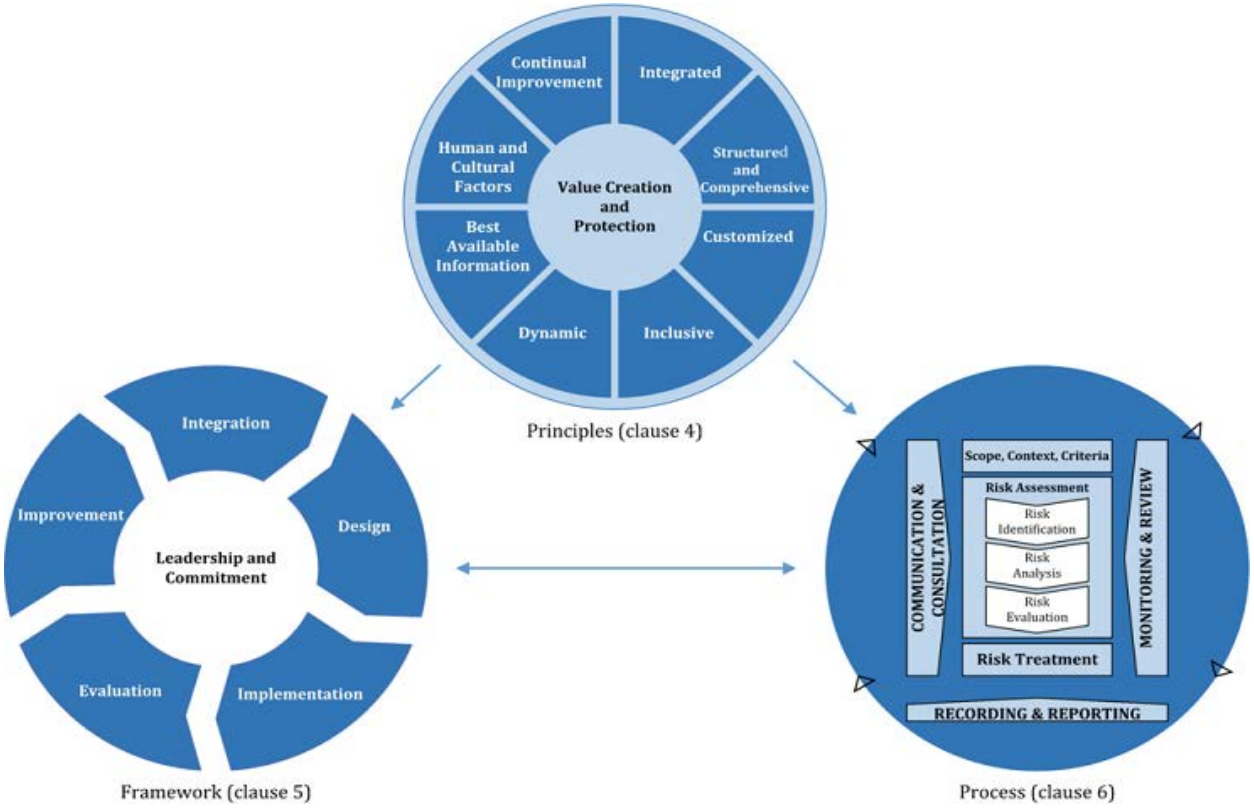

Figure 2. ISO 31000:2018 Source: International Organization for Standardization

ISO 31000:2018 defines that effective Risk Management have the following principles:

1) Integrated
2) Structured and comprehensive
3) Customised
4) Inclusive
5) Dynamic
6) Use the best available information
7) Take in consideration human and cultural factors
8) Continual improving

With the framework ISO 31000:2018 aims to assist organisations to implement effective risk management.

Framework includes the following:

- Leadership and Commitment

Top Management must ensure that risk management will be implemented throughout the entity.

- Integration

Understanding the organisational structure and context is necessary for successfully integrating risk management.

Top management must demonstrate and articulate their commitment to risk management. It must assign roles, authorities, responsibilities and accountabilities but also allocate the necessary resources for risk management.

- Implementation

Implementation must include a plan with time and resources, persons responsible for decision making and ensure that arrangements are clearly understood and practiced

- Evaluation

The effectiveness of Risk Management must be monitored to evaluate if it performs as expected and if remains suitable for promoting organisations goals.

2.5.3 Project Management Institute – Project Risk Management

Project Management Institute as analysed in the 6th edition of PMBOK Guide proposed the steps to be taken for a successful project risk management.

PMI in its risk management guide sees risk in a more holistic manner. They propose that the objective of project risk management should be the increase of probabilities and impact of positive risks and respectively the decrease for negative risks.

A. Plan Risk Management

The output of this step is the preparation of the Risk Management Plan which should include among others a risk strategy, the methodology, the roles and responsibilities within the organisation, risk categories probabilities and impact matrix and also stakeholders risk appetite.

B. Identify Risk

The organisation should identify individual risks as well the sources of those risks. The identification of the risks can be done with the use of various tools and techniques.

The output of this procedure is the preparation of a risk register which will include a comprehensive list of identified risks, the owners of those risks and a list of potential risks responses if such responses were spotted during the risk identification process.

C. Qualitative and Quantitative Risk Analysis

With qualitative risk analysis risks are prioritized based to their probability of occurrence, impact and other characteristics.

With quantitative risk analysis, risks are numerically analysed. It requires high quality data about each risk and uncertainty and a project baseline for scope schedule and cost.

Quantitative analysis should be performed for risks that were assessed as significant during the qualitative analysis.

D. Plan the risk Response

Organizations in this stage have to develop options, select strategies and agree on actions that will address overall project risk exposure and individual risks.

The benefit of an effective and appropriate implementation of risk response is that it minimizes threats and maximizes opportunities. Poor implementation may results in the opposite results.

PMBOOK Guide states that risk responses have to be “appropriate, cost effective, realistic, agreed by all parties involved and owned by a responsible person”.

Strategies for threats

1. Escalate – Threats outside the scope of the projects. Threats to be managed not on project level. Ownership must be accepted by the other party in the organisation
2. Avoid – Actions to eliminate threat. High priority threats
3. Transfer – Transfer ownership of threat to a third party
4. Mitigate – Actions to reduce probability of occurrence and/or impact
5. Accept – Acknowledge the threat. No proactive action taken. Low priority threat or no cost effective to address.

Strategies for opportunities

1. Escalate – Not managed on project level
2. Exploit – Increase the probability of occurrence to 100% - High priority opportunities
3. Share – Transfer ownership to third party
4. Enhance – Increase the probability of occurrence
5. Accept – Acknowledge the existence of the opportunity. No proactive action taken. Low priority opportunities

E. Implement risk responses

Organisations must ensure that the agreed upon risk responses are executed. As identified in PMBook Guide a common problem with Project Risk Management is that "*teams spend effort in identifying and analysing risks and developing risk responses, then risk responses are agreed upon and documented in the risk register and risk report, but no action is taken to manage the risk*"

F. Monitor Risk

Organizations Project Risk Management is an ongoing procedure that must be continually being monitored. The organisation should monitor and evaluate if the Implemented risk responses are effective, whether the level of overall project risk has changed or the status of identified risk has changed. They should also monitor for any new risk and whether risk management approach is still appropriate, project assumptions are still valid and if policies & procedures are being followed.

2.5.4 IRGC Risk Management Framework

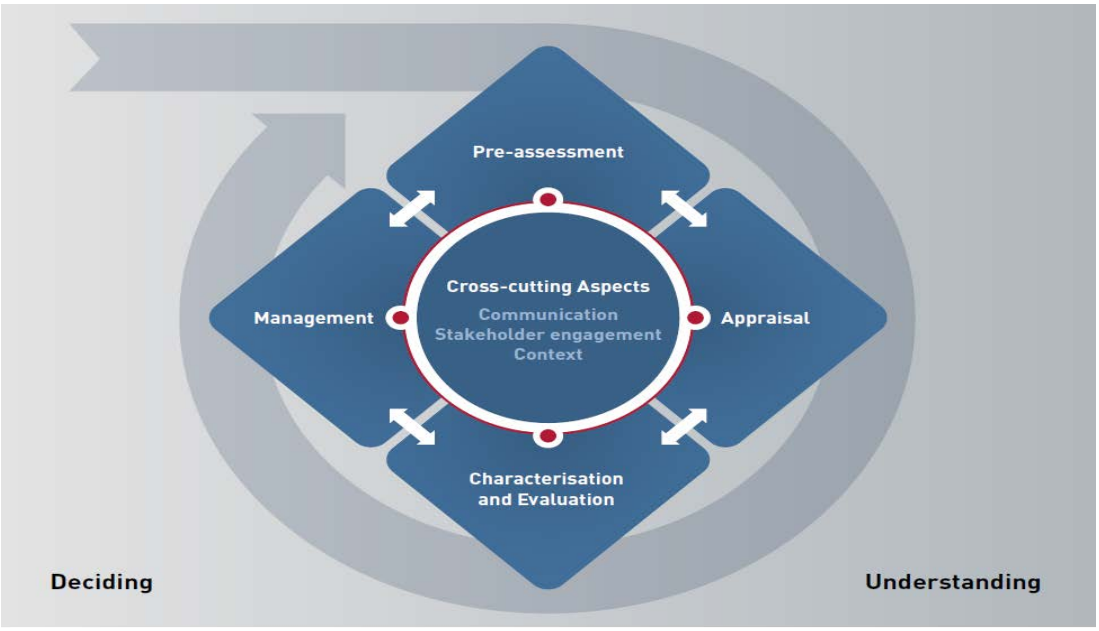

Figure 3. IRGC Risk Management Framework

IRGC Framework proposes a comprehensive approach for risk management. The Framework can be tailored for the needs of variety of business sector in order to be used for risk management.

IRGC Framework begins the process with the pre-assessment stage. This stage will lead the organisation to problem framing, early warning and preparations for handling the problem.

At this stage the Framework expects that an organisation will have to answer the following questions:

- What are the risks and opportunities that the organisation faces?
- Who are the stakeholders, what are their views and how they affect the identified problems?
- What is the relation between the stakeholders and the organisation?
- What are the various dimensions of the risk?
- What are the limits of the evaluation? (scope, scale and time horizon)
- What are the current problems?
- Should the organisation act on those problems?
- What scientific tools and methods can the organisation use to assess the risks?
- What is the current legal and regulatory system and how it affects the problem?
- What are the organisation capabilities?

Some common deficits that an organisation may face in this stage are that warning signals that should indicate risk may not be detected. The perception regarding the consequences of an event may not be perceived correctly and also there is the danger of the emergence of a “black swan” event, an unexpected extreme event that could not been foreseen.

In Risk appraisal stage IRGC Framework states that the organisation should develop the necessary knowledge that is necessary for the decision making process.

IRGC Framework indicates that risk appraisal except the risk assessment must include and a concern assessment.

For risk assessment the Framework expects from the organisation to address the following questions:

- What are the potential effects of the risks?
- What processes creates and control risk?
- Evaluate the vulnerabilities of the risk absorbing system.
- What accident scenarios could happen? How severe or probable they are?

- Is risk quantifiable?
- What is the level of confidence in the organisations risk assessment?
- Are the estimations of probabilities reliable?
- Are scenario development used for prospective risk assessment?

Some of the common deficits an organisation may face during this stage are the use of inappropriate methods and models to assess risk and lack of sufficient data for assessment of risks.

In concern assessment the organisation must identify the opinions and concerns of other stakeholders. This enables the organisation to take into consideration for a comprehensive risk appraisal the values and socio-emotional issues that are linked with risk. It acknowledges that decision making process is affected by past experiences, perceptions, emotions and values.

An organisation should aim to answer the following questions:

- What are the opinions, values and concerns of the various stakeholders?
- At what level they are involved, accountable or responsible
- Are any biases affect risk perception and concerns?
- Are there any sociological, anthropological or organisational constraints on stakeholders?
- How people react to risk? What is the possibility for socio-political mobilisation?
- How and at what level the public concerns are defined by existing institutions?
- What controversies and conflicts may arise from different risk perception?

Some common deficits that an organisation may face in this procedure is the failure to recognize factors that affect risk perception, scares or poor quality data and lack of proper attention to different stakeholders concerns and perceptions.

Characterisation and Evaluation

“Risk evaluation is the process of comparing the outcome of risk appraisal (risk and concern assessment) with specific criteria, to determine the significance and acceptability of the risk, and to prepare decisions” (IRGC, 2017)

Risks are different in nature. With the use of the knowledge developed during the risk appraisal phase the organisation must characterize risks based on their complexity as predominantly simple, complex, uncertain or ambiguous, or a combination of the above.

By characterizing risks the organisation can plan the level of participation of the stakeholders to the risk governance process and in designing the risk management strategies.

Simple risk can be managed with simple strategies and solutions where more complex risks will need a more comprehensive approach.

Risk Management must judge if a risk is acceptable, tolerable or intolerable. Acceptable risks will be accepted without the organisation taking any risk reduction measures. If a risk is evaluated as tolerable then the organisation will accept the risk but will have to take appropriate measures and strategies to reduce the risk. If finally a risk is evaluated as intolerable then the organisation should take all necessary actions to entirely avoid this risk.

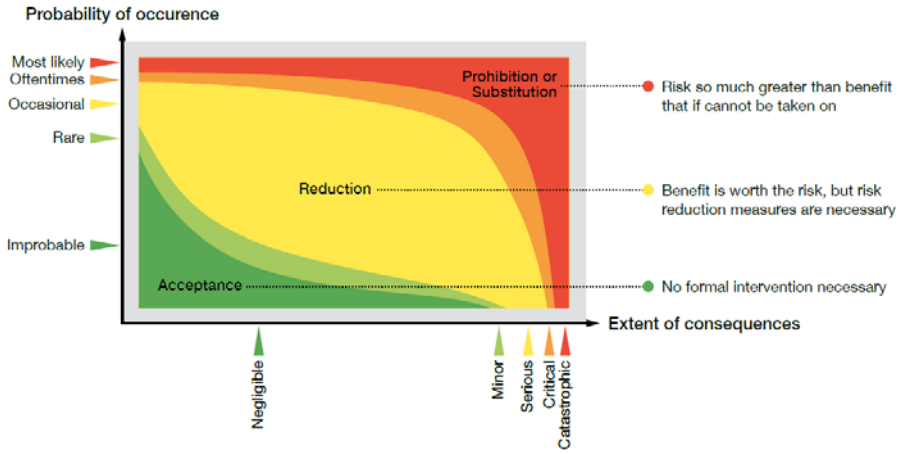

Figure 4. Risk Evaluation, Source: IRGC. (2017). Introduction to the IRGC Risk Governance Framework

In order for an organisation to evaluate a risk must answer the following questions:

- What other ethical issues should be considered besides the ones already identified during the risk appraisal phase?
- What are the social values and norms regarding risk tolerability and acceptability?
- Do any stakeholders have any reason for wanting a particular outcome from the risk governance procedure?
- What constraints does the organisation face in risk management process?
- What is the strategic appreciation of the economic, environmental and societal risks and benefits?
- How risk compares to other possible substitutes?

Organisations may fail to fully consider the outcomes from the risk appraisal phase and not take into consideration social needs, the impact of the decisions in the environment and cost/benefit analysis.

Other deficiencies may include the omission of other stakeholder's point of view and concerns, indecision, lack of transparency and accountability in risk decisions.

Management of Risk

"Risk Management is a process that involves the design and implementation of the actions and remedies required to avoid, reduce (prevent, adapt, mitigate), transfer or return the risks" (IRGC, 2017)

Organisations at the risk management phase have to answer the following questions:

- Who should be involved in the risk management process?
- What is the level of responsibility of each actor and stakeholder?
- Have these responsibilities been accepted?
- What options there are available? What are the evaluation criteria for choosing an option?
- What is the cost and benefit for each risk reduction option? What are the tradeoffs?
- How can the organisation ensure the long term effectiveness of the risk management process? Does the organisation take into consideration uncertainty and ambiguity?

The risk management process should facilitate systematic decision making.

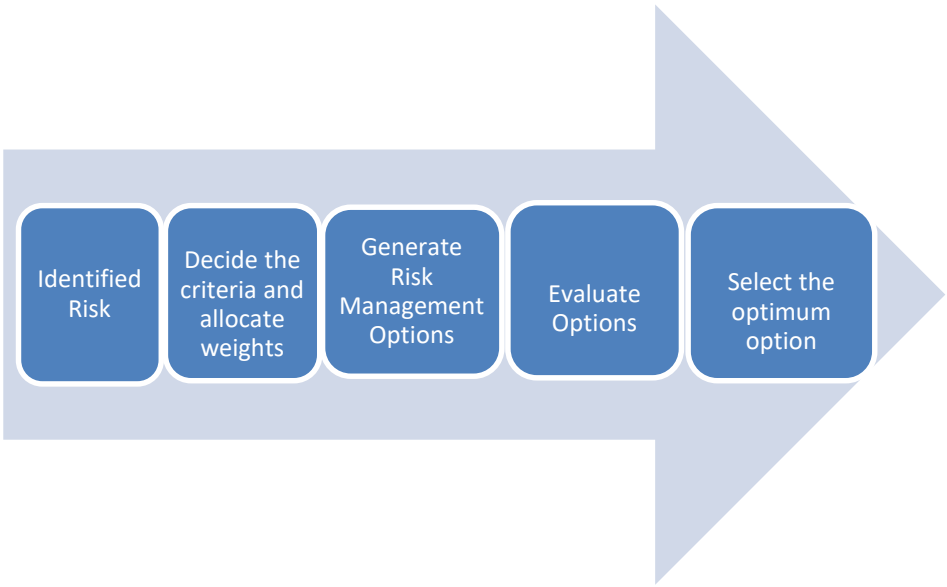

Diagram 1. Risk Management Process

Organisations should follow different strategies for risk management depending on each risk complexity and uncertainties involved.

- Simple Risks
  A routine based strategy can be used.
- Complex Risks
  Risk based decision making with the involvement of experts and the use of scientific models should be used. The organisations should aim for a risk informed and robustness focused strategy.
- Uncertainty Risks
  Precaution based and resilience focused strategies should be used. The organisation should aim to avoid the exposure to large uncertainties and reduce the vulnerability of its risk absorbing systems.
- Ambiguous Risks
  Discourse based strategies should be used. The organisation should aim to involve all interested parties in the process in an effort to reconcile conflicting views and values.

Some of the deficiencies that an organisation may face in the stage of decision making for risk management strategies are the lack of responsibility and accountability, decisions may not be sustainable in the long term, indecision from the organisation or decisions not taken on a timely base and finally the organisation may not taking equally into consideration risks and benefits.

After the decision is made the organisation must take the appropriate steps to implement the selected measures, monitor their effectiveness and revise the if deemed necessary.

For effective implementation the following conditions should apply:

- Appropriate authority and leadership
- Communication
- Effective management of change
- Clear definition of the roles, responsibilities and incentives
- Allocation of necessary resources

Organisations in this phase may have problems with implementing the decisions, the decisions may not be evaluated properly and feedback not integrated into the review procedure. An organisation may not take into consideration new data that affect risks and therefore fail to review and revise the risk management decision.

IRGC has in its core 3 cross cutting aspects that are crucial for successful risk governance.

- Communication
- Engagement of Stakeholders
- Context

Communication

Organisations must facilitate communication of risk related data, information and knowledge. Effective and timely communication enables the interested parties to develop a common understanding of their duties and their responsibilities (Internal Communication). It also assists all stakeholders and society to understand the risk and scope of risk management (External Communication).

Communication creates trust in risk management, especially in complex, uncertain or ambiguous risk.

The organisation to facilitate the communication process must answer the following questions:

- Is there a person in charge of facilitating the communication process?
- How the internal communication process can be organised and facilitated? (regulators, risk assessors and other internal experts)
- How the external communication process can be organised and facilitated? (external parties, stakeholders, media, risk managers)
- How can the organisation organise the communication in order a two way communication to be effective, enlightening and timely?

The content of communication must include:

- Knowledge regarding risk and hazards, who has this knowledge and how can this knowledge be communicated to all interested parties?
- Are perceived risks taken into consideration?
- Are there any ambiguities or controversies regarding the risk?
- What is the level of confidence to risk managers that they will facilitate communication?
- How sensitive and confidential information must be dealt?
- What are the demands for information and communication from various stakeholders groups?
- Are stakeholders concerns expressed through the communication process?
- How communicated information is interpreted by the involved parties?
- What is the role of media in this process?

Regular problems that organisations face with the communication process are the replacement of a two way communication with a one way information process and therefore eliminating the necessary dialogue. Another issue that an organisation may face is the language experts use can be very technical and hard to be understood by other parties. Uncertainties are often omitted during the communication; concerns and perceptions of third parties can be treated as irrationalities or deemed irrelevant and not given the necessary attention.

Stakeholder's engagement

IRGC Framework includes in its Risk Appraisal phase both a scientific risk assessment process and a concern assessment. With concern assessment the organisation is encouraged to take into consideration the views, perceptions and consequences of risk from other stakeholder's point of view.

The Framework states that the stakeholders that are affected from risk and risk management decisions should be involved in the process. Their involvement would benefit the organisation risk governance by providing useful insights.

Engagement of the stakeholders transforms the risk governance to an inclusive exercise which leads to a comprehensive risk management. This engagement of all relevant stakeholders increase the effectiveness of risk management and the resulting decisions are more likely to be widely acceptable.

The figure below presents the level and how wide the engagement should take place according to IRGC Framework.

The more complex and uncertain the risk is the wider the participation should be in the dialogue.

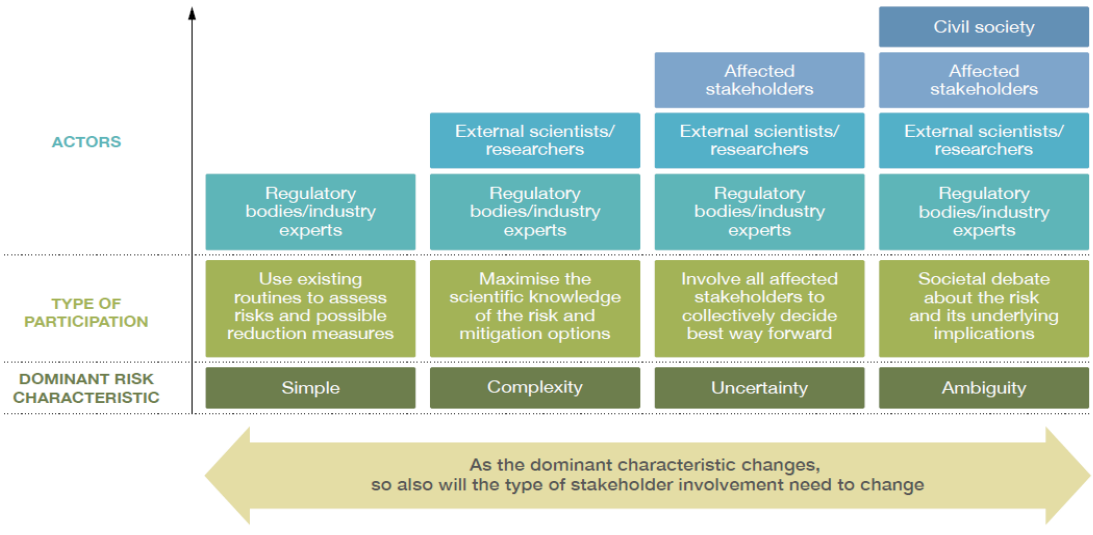

Table 2. Stakeholders engagement escalator Source: IRGC (2017) An introduction to the IRGC Risk Governance Framework

Some of the problem organisations faces are the exclusion of stakeholders and their views either on purpose or by accident.

Organisation may also tend to have an authoritarian attitude towards less powerful and influential stakeholders which leads to deliberate refusing the involvement of all relevant stakeholders in the dialogue.

The processes may lack inclusiveness for important risks or be too inclusive for insignificant risks. Too much inclusiveness for trivial risk produce unnecessary bureaucracy which in turns leads to a "paralysis by analysis" situation where no decision is taken or decisions are not taken in time.

Time pressures, restrictions and delays may diminish the importance that an organisation gives to the engagement of the stakeholders in the risk management process in an effort to save time and take quick decisions.

An organisation when it takes risk related decisions it must take into consideration social, institutional, political and economic context. It must recognize what assets, skills and capabilities the organisation has, who are involved, what is the political, legal and cultural framework within the organisation is operating.

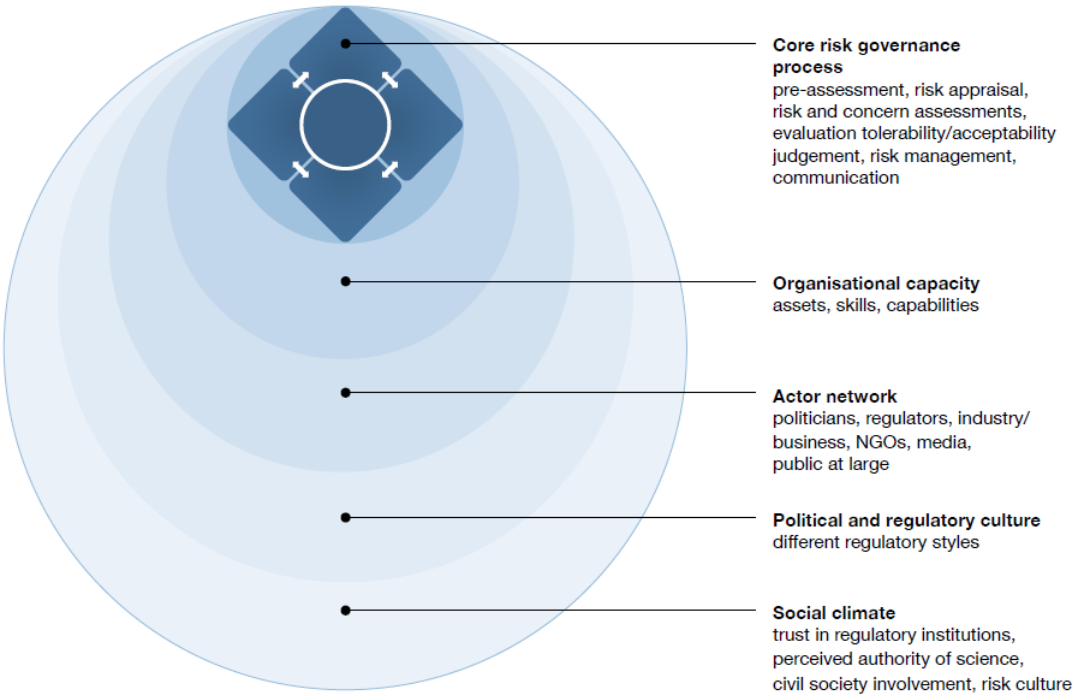

Figure 5. Risk Governance in Context Source: IRGC (2017) An introduction to the IRGC Risk Governance Framework

2.6. Risks in the Oil and Gas Industry

From the beginning of the hydrocarbon industry the problem of decision making taking into account risks and uncertainties was substantial. The first study that includes a formal analysis of economics and risks with the use of probability theory was the study of Allais in 1956 of the Algerian Sahara. (Suslick, Schiozer, & Rodriguez, 2009)

I.Lerche (I.Lerche, 1996) in its research in 1996 identified 4 major types of risks in exploration and exploitation of hydrocarbons. Economic risks include the future selling prices and the recovery efficiency of the total sunk costs in relation to estimated total project profitability. Political risks include war, higher taxation, government policy shifts and terrorism. Geological risks include incorrect analysis of the data and subsequently wrong estimates regarding the accumulation sites and amounts of hydrocarbons. The last type of risk that Lerche identifies is the drilling risk that includes risks of blow outs, encounter of high overpressure, destruction of drill pipes, earthquakes, mud slides and adverse weather.

A study of the Institute of Faculty and Actuaries made in 2016 which was based on the annual return of various companies in oil and gas industry identified the major risk as shown below based on each category:

- Economic
  Commodity price
- Environmental
  Natural Disaster
- Operational
  Industrial Accident
- Political
  Political Instability (including war)
- Resources
  Resources Availability

Except of those risks the study identified other risk such as credit risk, insurance risks, foreign exchange risks, transportation infrastructure etc.

In the diagram below the relation between those risks is shown

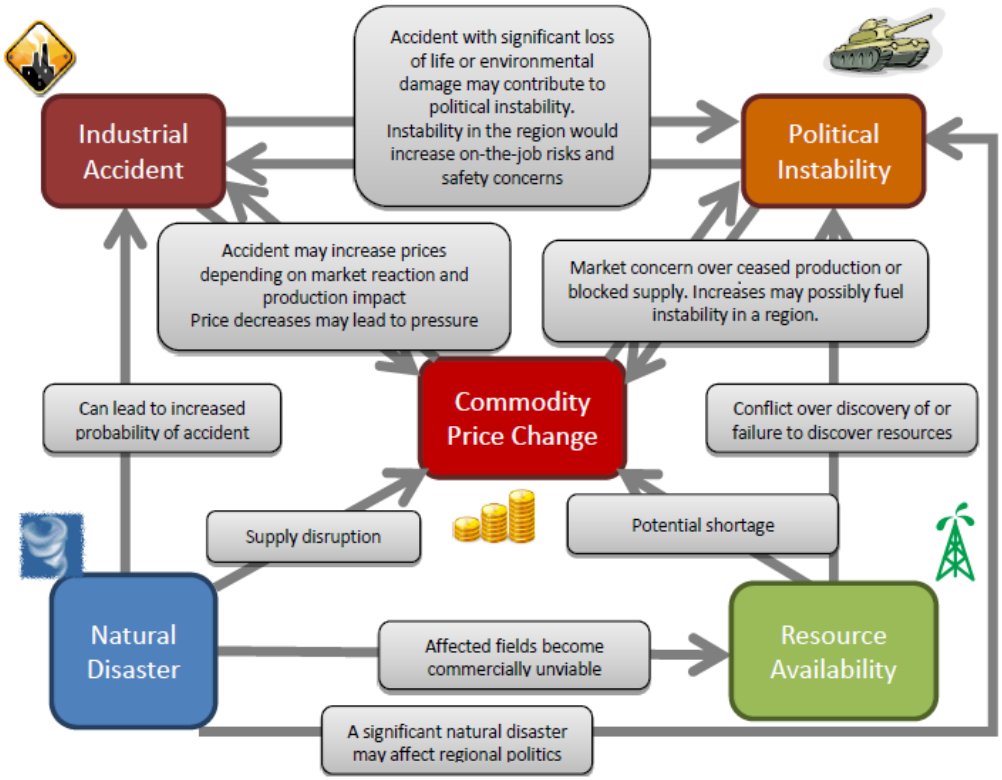

Figure 6. Relation between risks Source: Institute and Faculty of Actuaries

Oil and Gas operations are divided into two main activities, upstream and downstream. Upstream activities are the processes before processing and refining of hydrocarbon such as exploration, development of hydrocarbon fields and production. Downstream activities involve processes after extraction and transportation to terminals.

Upstream Activities	
Exploration	Analysing and interpreting seismic data to determine the potential of hydrocarbon reserves; drilling of test wells.
Conceptual Development	Performing screening studies to determine the most efficient and cost effective method to produce potential hydrocarbon sources. This would include selection of facilities (floating or moored structures), transport hydrocarbon from field to customer (pipeline, floating storage and offloading (FSO) vessels), corrosion mitigation strategies, and safety aspects of the operations.
Development	Project management of construction, detailed engineering, optimum well location, transport of facilities to location and commissioning of facilities.
Production	Maintenance strategies, planning budgets, analysis of supply and demand, and retrofit work to maintain or meet new production targets

Downstream Activities
Refining (gas processing and transmission)
Gas Distribution
Retail
Petrochemicals

Table 3. Upstream and Downstream Activities in Oil & Gas Source: A Review on Risks and Project Risks Management: Oil and Gas Industry

Reviewing the 2018 Annual Reports of Eni, Total and BP verifies that the above categories remain the main categories in which the above 3 companies identifies risks and uncertainties.

The interrelation of risk as show in the above picture can be identified and in Eni's 2018 Annual Report in which with the use of its "Integrated Risk Management" process have identified the various risk factors and uncertainties that can affect its organisation. Price of oil and natural gas is listed first on the risks that can have a material effect on the organisation. Eni identified the below factors as the ones that affect supply and demand and therefore the prices of oil and natural gas. Those are:

- Global political developments (such as sanctions and conflicts)
- Global economic and financial market conditions
- Ability of OPEC to control world supply
- Price and availability of alternative sources of energy
- Weather conditions
- Operational issues
- Governmental regulations and actions
- Success in development and deployment of new technologies for the recovery of crude oil and natural gas
- Rising commitment for addressing global warming

Reviewing Total's Annual Report for 2018 in which it acknowledge its exposure to various risk that can affect its performance it is noticed that again price of hydrocarbon is evaluated as one of the most significant risks with factors affecting prices been the same as the ones identified in Eni's Annual Report. Total adds to the factors the demographic changes in the world, notably the population growth and the consumers' preference.

Eni has implemented an Integrated Risk Management Model (IRM) which is based on international best practices.

The IRM process follows a top down and risk based approach. It includes six sub-processes. The Board of Directors with the help of the control and risk committee give the guidelines for the risk management. In Risk strategy Eni defines its strategic plan by identifying and analysing the risk profile of the company. Then the process continues with the risk assessment and treatment along with the risk monitoring. The evaluation of risk is done with the use of quantitative and qualitative tools. Finally risk reporting provides all the necessary information for the risk management. The CEO presents to the BOD every three months the main risks that the company faces.

Another sub process of Eni's IRM is the "Risk Culture" which develops a common language for risk management and develops awareness and managing risk across the company (S.p.a., 2019).

Total's Risk Management system is based on COSO Enterprise Risk Management, ISO31000:2018 and French Standards. The system is a continuous process of identifying and analysing risks in order to decide which risks could potentially prevent the company from reaching its goals.

Total has established a Group Risk Management Committee (GRMC) which is responsible for identifying and analysing risks. Risk Management cover financial risks, IT risks, ethical misconduct and non-compliance risks (TOTAL S.A, 2019).

BP in its Annual Report for 2018 indicates that its risk management system attempts to avoid incidents and to maximise the outcome for the company.

BP Risk Management system is established in order to understand the risk environment in order to identify and assess potential risks for the company. Then it is determined on how to deal and manage those risks and monitor the effectiveness of the risk management. The risk management process is reported on a periodic basis for the management chain to be informed on how significant risks are managed.

The main categories of risks that BP identifies in its Annual Report are the strategic and commercial risks that include the financial and geopolitical risks. Safety and operational risks includes risks regarding the health and safety of the company's personnel and environmental risks. Compliance and control risk includes legal and regulatory non-compliance and ethical misconduct.

BP has in place various committees both on executive and Board level that they oversight the Risk Management of the company. Executive committees handle different kind of risks such as commercial, health and safety, environmental, legal and regulatory risks (BP plc, 2019).

Chapter 3

Hydrocarbon Exploration Project in Cyprus

3.1 Exclusive Economic Zone Of The Republic of Cyprus

The Republic of Cyprus is a country located in the Mediterranean Sea. It's a member of the United Nations and a member state of the European Union.

Image 1. Map of East Mediterranean Sea Source: Vector Stock.com

The declaration of the Exclusive Economic Zone of the Republic of Cyprus had the following key steps.

In 1988 the Republic of Cyprus ratified the United Nations Convention on the law of the sea (UNCLOS) which defines "the rights and responsibilities of states in their use of the world's oceans, establishing guidelines for business, the

environment and the management of marine natural resources and regulating the territorial waters, contiguous zones and exclusive economic zones (EEZ) of states"

In 2003 a delimitation agreement of the Exclusive Economic Zone with the Arab Republic of Egypt was made. The agreement was ratified in 2004.

In 2004 the Republic of Cyprus passed the Exclusive Economic Zone and the Continental Shelf Law of 2004 64(I)/2004.

In 2007 a delimitation agreement of the EEZ with the Republic of Lebanon was made. The agreement is not yet ratified as Lebanon has objections regarding the Cyprus-Israel EEZ agreement. Lebanon position is that the agreement deprives Lebanon 854 square kilometers of its territorial waters. With a letter dated 17/07/2011 Lebanon officially notified the UN for its objection. Cyprus position is that the dispute is between Israel and Lebanon.

In 2010 a delimitation agreement of the EEZ with the State of Israel was made. The agreement was ratified in 2011.(Exclusive Economic Zone and Continental Shelf, 2016).

The Republic of Cyprus with the cooperation of the Norwegian company PGS Geophysical AS performed extensive seismic surveys and the data were evaluated from the French company Beicip Franlab. After the evaluation of the data the Republic of Cyprus announced its first Hydrocarbon Exploration Licensing Round Offshore Cyprus.

The EEZ of the Republic Of Cyprus was divided in 13 Blocks. With a notice published in the Official Journal of the European Union on May 2007 the Republic of Cyprus inaugurated the first round of licensing for 11 blocks (Blocks 3 and 13 were excluded). The result of the process was the licensing of Block 12 to Noble Energy International Ltd on October 2008.

In February of 2012 a second round of licensing resulted in Blocks 2,3 and 9 to be licensed to ENI/KOGAS and Blocks 10 and 11 to Total, Block 10 was later released by Total. In 2016 a third round of licensing resulted to Block 6 and 8 to be licensed to Eni and Block 10 to Exxon Mobil-Qatar Petroleum.

Licensing In the Oil and Gas Industry

In the Oil and Gas Industry there are four kinds of agreements.

The first one is the "Tax and Royalty" agreement. This agreement stipulates that the company will be given the right to explore, produce and market oil and gas. Royalties on production and tax on sales revenue will be paid to the Government granting the license.

The second type of agreement is the "Exploration and production sharing agreement (ESPA)". With this agreement the Government retain all hydrocarbon rights. The company bears all exploration costs and all associated risks. If the exploration is successful the two parties enters in an agreement where the exact share of development and production cost are agreed.

The third type of agreement is the "risk service agreement". The oil and gas company receives a fee for providing its services but do not get a share of the production. The company bears all costs for the exploration and the development. If the project is successful then the company recovers its costs through a predetermined recovery mechanism.

The fourth agreement is a simple service agreement. The Government pays a company for providing specific services, the company receives a fixed amount irrelevant of whether the project is successful or not. In this agreement all risks and rewards regarding the success of the project are retained by the government. (Saad A. Balhasana, 2019)

There are three types of licenses (a) prospection licenses, (b) exploration licenses and (c) exploitation licenses.

The prospection license is given with a maximum duration of one year and it gives permission for prospecting hydrocarbons with various activities excluding seismic surveys and drilling.

The exploration license is given for an initial period of maximum 3 years which can be extended to 7 years with the ability of two renewals of two years; in each renewal at least 25% of the licensed area is relinquished. The license gives exclusive permission for prospecting hydrocarbons with various activities including seismic surveys and exploration wells.

The exploitation license is given to the licensee in the case of a commercial discovery. The license is covering an initial period of 25 years which can extend

for further 10 years. The licensee then must implement development and production program in order to make the hydrocarbon discovery reserves marketable and able to be stored and transported.

The agreements regarding the licenses that the Republic of Cyprus has granted as of today are given on Appendix A

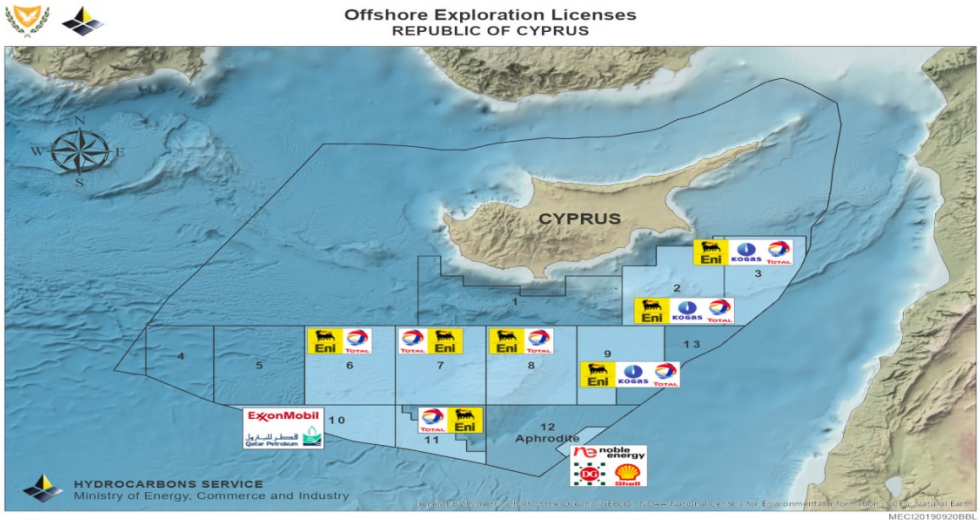

Image 2. Map of Licensed Blocks Source: Cyprus Hydrocarbon Services

The Republic of Cyprus has not come to delimitation agreement for its EEZ with Syria, Greece and Turkey.

The Syrian Arab Republic is in a state of civil war since 2011 (Central Inteligence Agency) and therefore was not possible to have a delimitation of EEZ agreement.

The Republic of Turkey invaded Cyprus in 1974 and has under military occupation 36% of the island since then. In 1983 the Turkish Cypriots declared the formation of the "Turkish Republic of Northern Cyprus" which is recognised only by Turkey. Turkey does not recognise the Republic of Cyprus and thus there is no possibility of reaching a delimitation agreement for the EEZ before the political settlement of the Cyprus problem.

Turkey claims Blocks 1,4,6 and 7 of Cyprus EEZ are within Turkeys EEZ and the Turkish Cypriot Community have legal rights in Blocks 1,2,3,8,9,12 and 13 (Antoniou, 2018)

With a Notification of the Minister for Foreign Affairs on the 6th of May 2019 to the United Nations, the Republic of Cyprus deposited a list of geographical

coordinates for its north and north-western limits of its EEZ. (United Nations, 2019)

The situation regarding EEZ of the Republic of Cyprus as of today is shown in the following picture with straight lines showing the agreed delimitation lines and the dotted lines the EEZ based on the Law of the Sea but without agreement with the neighbouring countries.

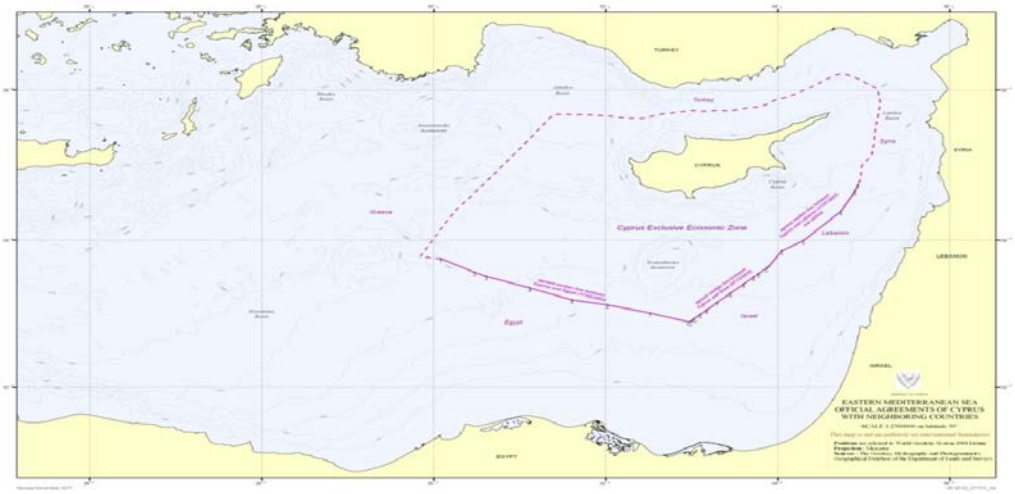

Image 3. Republic of Cyprus EEZ Source: Ministry of Foreign Affairs Republic of Cyprus

Other Agreements

The Republic of Cyprus has signed with the Arabic Republic of Egypt in 2013 a "Framework agreement concerning the Development of Cross Median Line Hydrocarbons Resources". For the same reason Cyprus Goverment is in negotiations with the State of Israel and talks started with the Republic of Lebanon to reach an agreement.

Agreement for "Exchange of Information and Confidentiality Agreement" was signed in 2006 with Egypt and 2014 with Israel.

3.2 LNG Terminal in Cyprus

With the initial discovery of natural gas in "Aphrodite" which was estimated in 7 tcf it was proposed the construction of an LNG Terminal in the area of Vasilikos.

The proposed plan included the construction of facilities for receiving, refining and liquefying natural gas. Units for electricity production, operating, control and management centre, storage facilities, facilities for transporting LNG to ships for export and other supportive facilities.

Based on the initial plan the site could facilitate up to 3 LNG production units of 5 MTPA (million tonnes per year) capability each and two LNG storage tanks of 180.000m^3 each.

The unsuccessful exploration wells of "Onasagoras-1" and "Amathusa-1" along with the reduction of the estimated natural gas reserves of "Aphrodite" affected negatively the viability of the project and it was suspended for now.

3.3 Legal Framework for Hydrocarbon Exploration in Cyprus "Hydrocarbon (Prospection, Exploration and Exploitation) Laws of 2007 to 2015 (L4(I)/2007)"

The hydrocarbon exploration and exploitation activities in the Republic of Cyprus (including its EEZ) are regulated by the "Hydrocarbon (Prospection, Exploration and Exploitation) Laws of 2007 to 2015 (L4(I)/2007)" and the "Hydrocarbon (Prospection, Exploration and Exploitation) Regulations of 2007 to 2014"

The above law incorporates the European Union directive regarding hydrocarbon exploration and production.

All activities regarding hydrocarbon prospection, exploration and exploitation are subject to the Cyprus legislation on environmental protection, health and safety.

The Law L4(I)/2007 states that the Council of Ministers have the authority to decide the areas that will be given for licensing hydrocarbon activities. The Council have the authority to deny access to the procedures to any entity controlled by foreigners on the grounds of national security.

The Council or the Minister of Energy, Commerce and Industry after the approval of the Council can publish to the Official Gazette of the Republic and the Official Journal of European Union notice of interest for any interested party to apply for license.

The Council have the right to directly give a license without the above procedure if the licensed area was:

a) Available on a permanent base

b) It was available in previous licensing rounds without success
c) It was abandoned by an entity

The Council can also directly license an entity if geological and production criteria justify licensing an area to an entity that has already license in a neighbouring area.

The law establish a consulting commission made up from:

- The General Manager of the Ministry of Energy, Commerce and Industry (acting as President of the commission)
- The Attorney General
- The General Manager of the Ministry of Finance
- The General Manager of the Ministry of Agriculture, Rural Development and Environment
- The Manager of the Geological Survey Department
- The Manager of the Hydrocarbon Services

The Consulting Commission has the responsibility to evaluate all issues regarding the above law and consult the Minister of Energy, Commerce and Industry. Among the issues the Commission has to evaluate are:

a) The level of Risk to the environment that may result from licensing an entity and propose suitable measures to protect the environment
b) Safety measures that must apply
c) Safety measures in order to protect ship navigation

The Consulting Commission has the right to invite external specialists and to establish special technical commissions to help with its duties.

Based on the Law L4(I)/2007 all entities operating in exploration and exploitation of hydrocarbon activities have to oblige to the "Estimation of Impact in the Environment Law L127(I)/2018" and have to acquire license as prescribed in Article 4 of the "Protocol for the Protection of the Mediterranean Sea against pollution resulting from exploration and exploitation of the continental shelf and the seabed and its subsoil"

The Council of Minister must take into consideration the ability of the applicants to fulfil the requirements of the European Union Law and especially the "Directive 2013/30/EU of the European Parliament and of the Council of 12 June

2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC Text with EEA relevance"

For applying the above during the evaluation process the Council must take into consideration the followings:

(i) The level of danger and the risks of negatively affecting the quality of the sea environment as per the "Sea Strategy Law of 2011 L18(I)/2011"

(ii) The stage of the hydrocarbon activities

(iii) The financial capabilities of the applicant, including their capabilities for covering any damages during their operations

(iv) Any available information regarding the applicants' history on safety and environment protection.

The Council must also take into consideration the "Protection and Management of Nature and Wild Life Law of 2003 to 2012 (L153 (I)/2003)" and the "Protection of Wild Birds and Game Law of 2003 to 2014 (L152(I)/2003)"

Licenses are granted if the terms and conditions can ensure that:

- Correct performance of the activities that the license permits
- Payment of contribution to the Republic either in money or hydrocarbons
- National Security
- Public Safety
- Public Health
- Transportation security
- Environmental Protection
- The protection of biological and mineral resources and national treasures
- The safety of infrastructure and employees
- The planned management of the hydrocarbon resources
- Ensures the Republics Revenues
- Necessary resources to manage their financial responsibilities

Based on the Law the management of the Republic's participation in the prospection, exploration and exploitation for hydrocarbons can be transferred to a Public Entity which will be directed by a 7 member Board of Directors. All 7 members will be Non-Executive directors with one of them acting as the President of the Board.

The Republic of Cyprus has established the “Cyprus Hydrocarbons Company” on March 2014 as the successor of the “National Oil Company” that was established as a private limited company in 2012.

All the information that any person receives based on this Law are considered confidential. This imposes a significant restriction to the master dissertation.

Chapter 4
Source of Information

This master dissertation is an attempt to evaluate the risks that the Republic of Cyprus will face during all stages of the hydrocarbon exploration project with qualitative methods. It also attempts to propose a structured approach on managing those risks using a risk management framework.

A number of Risk Management Frameworks and Standards have been studied and presented in this master dissertation. Those Frameworks and Standards were chosen to be analysed as they were the most popular among the available bibliography, they were prepared by respected international organisations and they have been used for similar projects.

The data for the thesis have been collected using existing records and documents.

4.1 Risks in the Hydrocarbon Exploration in Cyprus

As countries are big and complex organisations in the project of hydrocarbon exploration there is involvement of various entities that act on behalf of the Republic. The most significant ones are:

- The Ministry of Foreign Affairs
- The Ministry of Energy, Commerce and Industry
- The Hydrocarbon Service
- The Cyprus Hydrocarbons Company
- The Department of Environment

All the above entities work together to handle the various aspects of the hydrocarbon project.

The Hydrocarbon Service is responsible for implementing policies that aims in the efficient, effective and viable exploitation of Cyprus's hydrocarbon resources

in order to maximize Cyprus revenue for the benefit of the society and the future generations.

The Hydrocarbon Service with the cooperation of the Ministry of Foreign Affairs aim to strengthen the geostrategic role of the Republic through a stable economic environment that promotes investments, the involvement with other countries in seminars and forums relating to the exploration and exploitation of hydrocarbons. Cyprus also participates in the European Union initiative of the Euro Mediterranean Gas Platform (EMGP)

The data regarding the current situation with the existing agreements and the development so far in the hydrocarbon project were collected from the official websites of the involved departments of the Republic of Cyprus (Ministry of Energy, Commerce and Industry, Hydrocarbon Service Department Ministry of Foreign Affairs, Cyprus Hydrocarbon Company,), the United Nations, the European Union as also from interviews of Cyprus's Officials to the Media.
The aspect of other stakeholders was examined through their official and public announcements.

4.2 Identification of Risks

Common risk factors in the oil and hydrocarbon business were identified through literature review of published articles on the risk management in the oil and gas sector. Another source of information regarding risks were the Annual Reports of Eni, Total and BP for 2018 were they present the risks that they have identified that can materially affect the operations of their companies.
From the Annual Reports of the above companies was also reviewed how this companies manage those risks and what procedures they have in place for Risk Management.
Data were extracted from official announcements and interviews made from officials and experts on the subject to reliable Media.

Studies made on behalf of the European Commission were proven also a useful source of vital information that was used for this master dissertation.

4.3 Analysis of Risk Management

The analysis of risk management of the hydrocarbon exploration from the Republic of Cyprus was performed with the use of the IRGC Framework.

The IRGC Framework was chosen because it provides sufficient guidance for identifying and managing risks that involve multiple stakeholders.

The Framework includes guidance for every aspect in risk management of important risks that are characterised by complexity, uncertainty and ambiguity.

A significant advantage of the IRGC Framework for Risk Management is its generic and adaptable nature which allows the user to customise it in order to be tailored to the special characteristics and needs of the organisation.

It must be noted that it was not possible to have access to the official risk management policies of the Republic of Cyprus. This is due to the fact that based on the local legislation all the information regarding the hydrocarbon exploration project is regarded as confidential and therefore neither the Hydrocarbons Service of the Ministry of Energy, Commerce and Industry nor the Cyprus Hydrocarbons Company were allowed to provide as any further information other than the ones that are already publicly available through their official websites.

Chapter 5

Implementation of IRGC Framework

In this chapter of the master's dissertation the IRGC Framework on Risk Management will be implemented on the specific case of the Cyprus Hydrocarbon Project. The risks are divided into two categories, risks related to economic and political factors and risks related to environmental factors. The pre-assessment stage is presented together for both of the two categories and then for each risk categories the appraisal, characterisation and evaluation, management and cross cutting aspects are presented separately.

5.1 Pre- Assessment

The Republic of Cyprus is an island state located in the eastern Mediterranean Sea with Turkey on its north, Lebanon, Syria and Israel on its east, Egypt on its south and Greece on its west. Cyprus is a member state of the European Union.

The Republic of Cyprus will have to address certain risks and opportunities throughout the management of the hydrocarbon project. Those risks can be categorised in the following categories:

(a) Economics

(b) Environmental

(c) Operational

(d) Political

(e)Resources

(f) Transportation Infrastructure.

The above categorization is proposed by the Institute of Faculty and Actuaries (Party, 2016)

This master dissertation will focus on the economic, political and environmental risks related to the project.

Cyprus has come to delimitations agreement of its EEZ with Israel and Egypt while an agreement was reached with Lebanon which is not yet ratified.

Syria is in a state of civil war since 2011 and therefore was not possible to have a delimitation of EEZ agreement.

Cyprus has an on-going political problem with Turkey which invaded the island in 1974 and is since then occupying 37% of the island. In 1983 the Turkish Cypriots declared the "Turkish Republic of Northern Cyprus" which is recognised only by Turkey. The Republic of Cyprus is not recognised by Turkey and therefore there is no diplomatic relations between the two countries.

Cyprus divided part of its EEZ into 13 blocks and after performing 3 international licensing rounds has licensed 9 blocks to international companies. Eni, Total and Exxon-Mobil are some of the companies that have been licensed.

Turkey has not signed the UNCLOS conventions and claims a significant part of Cyprus EEZ as part of its own EEZ or part of the "Turkish Republic of Northern Cyprus" EEZ.

Cyprus and Greece have not signed a delimitation agreement. The most significant factor for failing to sign such agreement are the concerns that this could potentially cause high tensions between Greece and Turkey. Turkey except Cyprus EEZ claims part of Greece EEZ as it does not recognise that Greek Islands must be taken into consideration for the EEZ.

The hydrocarbon exploration and exploitation activities in the Republic of Cyprus (including its EEZ) are regulated by the "Hydrocarbon (Prospection, Exploration and Exploitation) Laws of 2007 to 2015 (L4(I)/2007)" and the "Hydrocarbon (Prospection, Exploration and Exploitation) Regulations of 2007 to 2014"

The above law incorporates the European Union directive regarding hydrocarbon exploration and production. All activities regarding hydrocarbon prospection, exploration and exploitation are subject to the Cyprus legislation on environmental protection, health and safety.

Identification of Stakeholders

During the pre-assessment phase the entity must acknowledge the presence of various stakeholders and that they may have contradicting interests and views to the project's risks. For assessing the various risks that have been identified the Government of Cyprus must identify who are the stakeholders, what are their views and how they could affect the project.

- Local communities

Various infrastructures will have to be constructed onshore that will provide significant services for the offshore activities. Local communities were these infrastructures will be place can be more sensitive to air and noise pollution as they will be directly affected. Depending on the size of the communities they may have significant power through political pressure to the government and other political parties.

- Coastal communities

As the project have a risk of damaging the sea water quality the communities that lives near sea will be more likely to be more sensitive to this kind of environmental risks. Again depending on their size they can have significant power through political pressure to the government and other political parties.

- Fishers - Aqua farming

As above this group of people have a significant interest in the sea water quality as it is their main source of income with significant investments in the area. A significant pollution of the sea could cause the loss of their investment.

- Environmental organisations

Environmental organisations can have a significant impact on the Hydrocarbon Project. International environment conservation organisations have an increasing power and could cause significant problems through pressure to foreign government and the European Union to the Government of Cyprus if their views are not taken into consideration.

- Political Parties

Due to the interrelation of the hydrocarbon exploration project with the Cyprus problem and efforts for its solution various political parties may have different approaches on how the Government should proceed with the project. The political parties have significant powers through their legislative activities and the Government should take their views into consideration

- Countries in the region

Politics in the Eastern Mediterranean sea and the Middle East are very complicated. Throughout the last century the region is a source of constant tensions. Countries that should be considered as stakeholders, except the Republic of Cyprus, are Egypt, Israel, Turkey, Lebanon, Syria and Greece.

All the above countries have different and many times conflicting interests which make the management of those different interests a very complicated process.

Turkey has invaded Cyprus and is military occupying a part of the Republic since 1974. Turkey do not recognise the Republic of Cyprus and therefore its EEZ.

Israel and Lebanon had a series of wars between them in the last 60 years with the last one been in 2006 and with constant tensions between the two countries since then.

The Palestine problem also is a source of tensions between Israel and the Muslim countries of the region.

Turkey and Syria have an on-going military conflict.

- Oil and Gas companies

The companies that will operate in Cyprus EEZ will have to invest significant capital in order to find and extract hydrocarbons from the EEZ. Therefore they will be interested in having a stable political environment and have the best possible agreement with the Republic of Cyprus regarding their share on the revenues. They will also have significant interest in not disturbing their relationship with Turkey as many of these companies have significant economic investments in Turkey (Exxon Mobil, 2020) (Total, 2020) (Eni, 2020).

- Oil and Gas Companies Countries

The companies that have presence in Cyprus's EEZ so far come from France, Italy, USA and Qatar. These countries want to protect the interests of their companies. As these countries could provide a useful ally to the Republic of Cyprus their views should be taken into consideration while assessing the risks.

- United Nations – Permanent members of the UN Security Council

As Cyprus Problem is still unresolved and the United Nations have a constant presence in the island with a peacekeeping force their views should be considered. The permanent members of the UN Security Council are USA, France, United Kingdom, Russia and China.

- European Union

As a member state since 2004 and a large proportion of the Republic's rules, regulations and legislations are decided on a European Level, the European

Union is a significant stakeholder and its views should take into consideration as its decisions can have a significant impact on the project.

The Risk will be placed on a diagram as the one show below

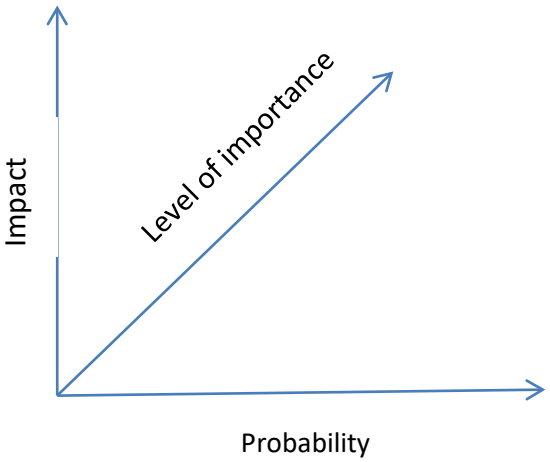

Diagram 2. Level of Importance

The risk will be categorised as low, medium, high and very high. The factors for determining the categorisation of each risk will be the probability of happening and the impact it will have to the project.

Probabilities will be categorised as extremely rare, rare, occasional, likely and highly likely.

Impact will be categorised as slight, minor, moderate, major and catastrophic.

Impact Categories:

Trivial – The impact is short term (days) and with no significant effect to the project

Small – Impact is of longer term (weeks and months), impact has no significant effect to the project but it may require actions to mitigate the effect

Medium – Impact is long term (years), impact has a significant but of low severity effect to the project

High – Impact can be short or long term but with significant effect on the project

Catastrophic – Impact will be of long term (several years) with very significant effect on the project which could cause the total failure of the project.

Probabilities Categories:

Extremely Rare – There were no previous incidents and the probabilities are extremely low

Rare – Incidents have been occurred in the past but with very low frequency

Occasional – Incidents have been occurred in the past more frequently

Likely – Incidents are happening frequently, there is high probability of an incident occurring

Highly likely – Incidents have been occurred several times in the past with high frequency. There is a very high probability of an incident occurring.

Impact						
Probability		Trivial	Small	Medium	High	Catastrophic
	Extremely Rare	L	L	L	L	M
	Rare	L	L	M	M	H
	Occasional	L	M	H	H	VH
	Likely	L	M	H	VH	VH
	Highly Likely	M	H	VH	VH	VH

Matrix 1. Risk evaluation matrix

Where L = Low, M=Medium, H=High and VH= Very High

Depending on the assessment of the risk the Republic will have to manage the risk.

Risks that will be evaluated as Low will be considered as acceptable and therefore no risk reduction strategies will be implemented.

Risk that are evaluated Medium and High will be considered as Tolerable risks which means that they may be pursued but risk reduction measures will have to be implemented.

Finally risks that will be evaluated as Very High will be considered intolerable and all necessary steps will have to be taken to avoid them.

For the purpose of this master dissertation any risks that were evaluated as low will be deemed as acceptable risk and no further management actions will be proposed.

5.2.1 Appraisal for risks related to economic and political factors

Political and economic risks are both ambiguous and complex risks. They involve many different stakeholders who they have different points of view and

they involve many unknown variables and uncertainties about events that may happen in the future and the Republic of Cyprus have limited control over them.

5.2.1.1 Risks related to economic factors – Oil Prices

As identified in the annual report of all major Oil and Gas Companies hydrocarbon prices is a significant risk for the project. If the global prices are low then the viability of the whole project can be affected.

As it was stated earlier the main factors that can affect the prices are the variation in global supply and demand for energy, the political situation in oil and gas producing countries, the ability of OPEC to control the global production, new technologies that provide alternative sources of energy such as green energy technologies and global economics.

As it is obvious from the factors affecting the hydrocarbon market prices, the Republic of Cyprus has no control over the prices.

Energy markets are expected to significantly transform over the next years. The abundance of oil and gas resources along with the global efforts to transform the local economies to low carbon energy economies are pushing the prices down.

BP Energy Outlook of 2019 (BP, 2019) estimates that by 2040 global energy demand will increase by a third. Renewable sources of energy will continue to be the fastest growing sector in energy while natural gas will grow faster than oil.

BP Energy Outlook also expects that LNG will be a more favorable solution than pipelines and LNG will surpass inter-regional pipeline shipments by the late 2020's.

Mr. Charles Ellinas (Ellinas, 2017), a former CEO of the Cyprus National Hydrocarbon Company, have already indicated that discovering hydrocarbons in Cyprus EEZ is not by itself sufficient for the success of the project. Those fields will have to be developed and then someone will have to buy those extracted hydrocarbons.

He also identifies the changes in the world energy mix with renewable sources of energy along with new technologies for energy efficiency are going to push down the demand of fossil fuels and therefore put pressure on their prices.

European Union has set a target to reduce by 40% the greenhouse gas emissions by 2030. It has also set as a goal to have at least 32% its total needs for energy produced with the use of renewable sources and have at least 32.5% improvement in energy efficiency. The framework was adopted in 2014 and it has been already revised upwards in 2018. (European Commission, 2020). This indicates that there is high probability that those goals will be revised upwards again in the near future. These measures mean that the demand for

hydrocarbons in Europe may be less in the near future reducing even further the market prices.

The volatility of the global market prices and how susceptible these are to political decisions taken by third countries was demonstrated once again this March when Saudi Arabia and Russia launched a price war and the market was flooded with excessive supply of oil which made the oil and natural gas prices to crash (Egan, 2020). Oil prices was found to be trading less than $20 per barrel and Natural Gas less than $1.6/MMBtu (Bloomberg.com, 2020)

Another factor that must be considered is that according to Mr. Ellinas analysis of the data from BP and the International Energy Agency, a large percentage of the remaining recoverable oil and gas will eventually remain unexploited due to the technological advancement and the adoption of green energy technologies.

5.2.1.2 Risks related to political factors – Cyprus Problem

Because of the complex political situation with the unresolved Cyprus Problem the delimitation of the EEZ is another area that relates to risk. As mentioned Turkey do not recognize the Republic of Cyprus and neither it's EEZ. Turkey has not signed the UNCLOS, mainly because of its claims on the Aegean Sea (Ayla Gürel, 2013). Turkey position is that the delimitation agreements that the Republic of Cyprus have signed are not valid and the agreements were objected in the UN (United Nations, 2020).

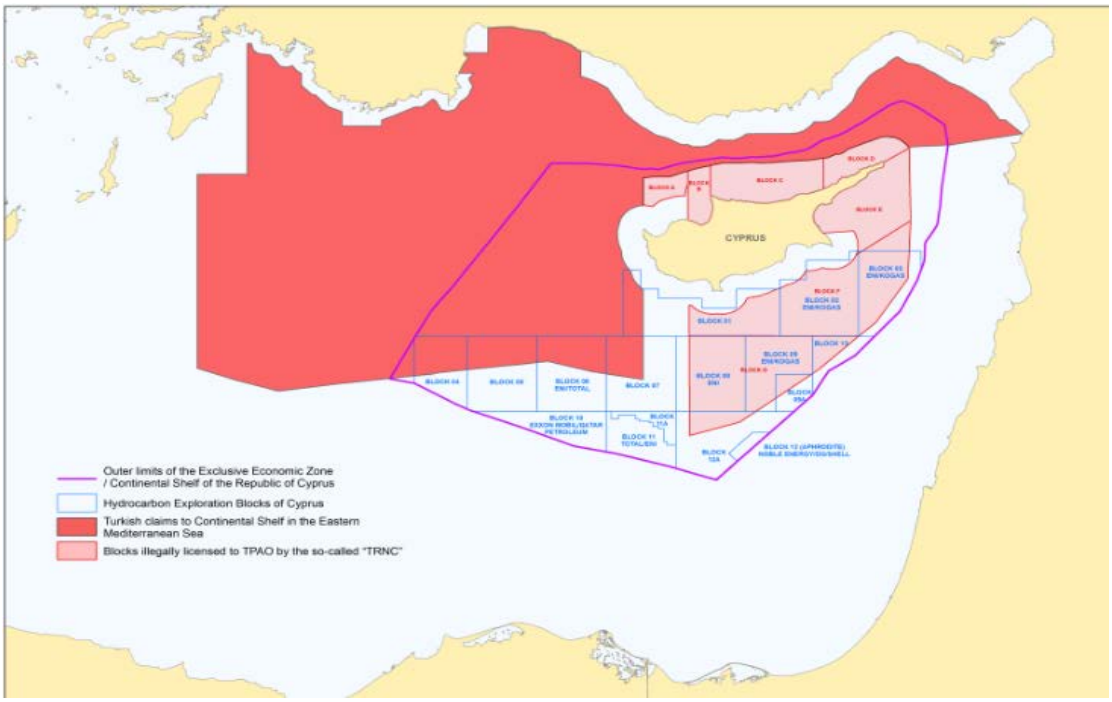

Image 4. Turkeys claims in Eastern Mediterranean including Cyprus' EEZ. Source: Ministry of Foreign Affairs, Republic of Cyprus

As it can be seen in the above map, Turkey claims a big part of Cyprus EEZ as its own or part of the so called "Turkish Republic of Northern Cyprus".

Turkey has already proceeded with a number of exploration drills in Cyprus EEZ which were declared as illegal by the Cyprus Minister of Foreign Affairs (Ministry of Foreign Affairs of the Republic of Cyprus, 2019). Turkey in order to proceed with its illegal activities has already acquired three drilling ships (Euronews, 2020).

In February of 2018, during a drilling expedition from Eni to the licensed Block 3, Turkish nave obstructed the process and Eni was forced to withdraw its vessels from the area without completing the exploration drill (Press and Information Office, 2018).

Turkey in an effort to gain support to from neighbouring countries and weaken the position of the Republic of Cyprus has proposed a distorted view of how the Exclusive Economic Zones of Cyprus should be delimited between the countries.

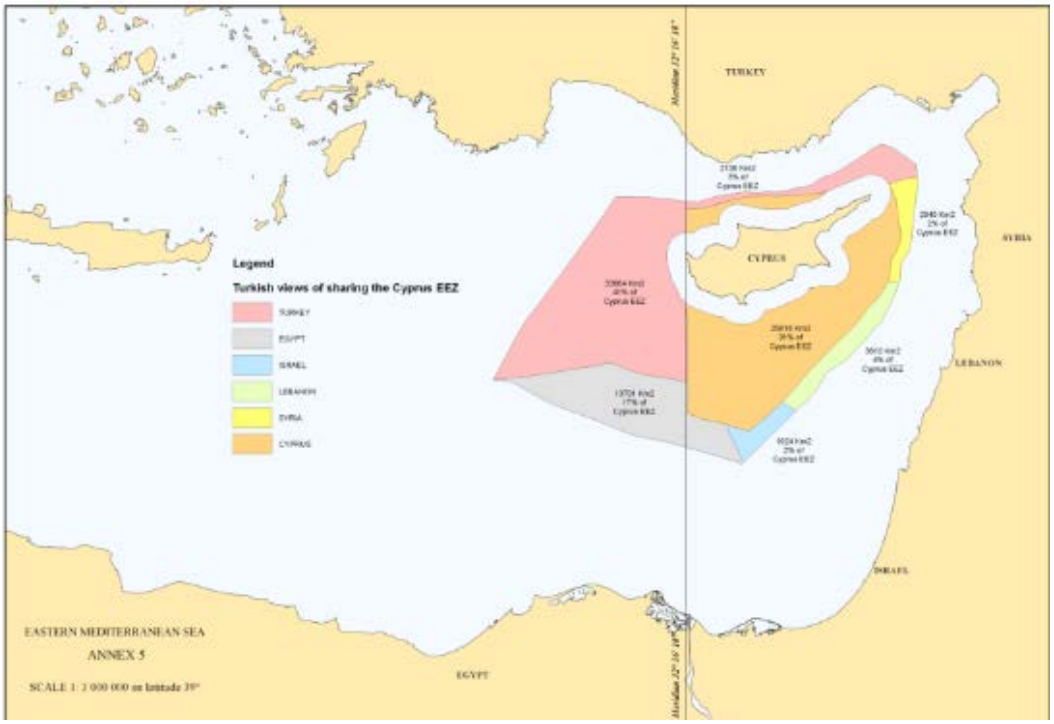

Image 5. Turkish View of how Cyprus' EEZ should be shared. Source: Ministry of Foreign Affairs, Republic of Cyprus

This would mean that Cyprus would lose 69% of its EEZ including the Aphrodite field.

Based on a research done by the IMR/ University of Nicosia in 2018 21% of the people were very worried and 45% were significantly worried about the Turkish actions relating to the hydrocarbon exploration. In the same research 78% of the

people believe that Cyprus negotiating power will improve if the hydrocarbon exploitation is successfully continued.

5.2.2 Characterisation and evaluation of risks related to economic and political factors

Incident	Risk	Impact	Probability	Risk Level
Low prices in the global market before the production stage begin	Project becoming economically non viable	Catastrophic	Rare	High
Low prices in the global market during the production life cycle stage	Project non-viable – Infrastructure becoming redundant	Catastrophic	Rare	High

Both incidents would have a catastrophic impact on the project but as those risks are inherent with the project and therefore cannot be avoided the Republic will have to take all necessary measures to reduce those risks.

The first incident is where the prices are at such levels that the Republic cannot find any willing company to participate in the project or the companies postpone or even cancel their plans for exploration and exploitation.

In that situation the Republic will probably not yet heavily invested in infrastructures. Also, as there will be no significant revenue from the sector, the Government budget will not be dependent on those revenues. This can give more flexibility to the Government to take measures to reduce the risk.

The conflict between the Republic of Cyprus and Turkey creates the following risks:

Incident	Risk	Impact	Probability	Risk Level
Armed conflict with Turkey	Cancellation of project until political solution	Catastrophic	Rare	High
Turkey Navy Blocks the ships from performing exploration and exploitation activities	Withdrawal of companies from the EEZ	High	Occasional	High

Incident	Risk	Impact	Probability	Risk Level
Turkey performs exploration and exploitation activities in Cyprus EEZ	Cyprus hydrocarbon reserves been exploited by Turkey	High	Occasional	High

5.2.3 Management of risks related to economic and political factors

Incident	Risk	Impact	Probability	Risk Level
Low prices in the global market before the production stage begin	Project becoming non economically viable	Catastrophic	Rare	High
Low prices in the global market during the production life cycle stage	Project non-viable – Infrastructure becoming redundant	Catastrophic	Rare	High

Some of the measures that the Republic could take would be to license more blocks to fewer companies in order to gain economies of scale that could reduce the production cost.

Another step that the Republic can take is to transfer all or part of this risk to Oil and Gas companies by giving them a larger share of any discovered hydrocarbons in return from the companies to bear all or the majority of the costs for the exploration and development of the hydrocarbons in the EEZ.

So far it seems that Cyprus has chosen both of these options. Observing the map with the licensed blocks it can be identified that the majority of the blocks have been licensed to Eni and Total. Also based on the license agreements made by the Republic the cost for the exploration drilling and all relevant infrastructures has been assumed by the companies.

Also the Republic will have to take initiatives to speed up the process of developing and selling the hydrocarbons as it is generally accepted by both scholars and companies that with the advancement of green energy technology the hydrocarbon prices will be reduced in the future.

There is a discussion in Cyprus of how the hydrocarbon reserves found in its EEZ will be best exploited. The options proposed are:

- The exportation of the discovered reserves directly to Europe through the construction of a pipeline.

- Construction of an LNG plant onshore where the discovered reserves would be transported through a pipeline liquefied and then exported by LNG tanker.

-The export of the discovered reserves to LNG plant in Egypt.

- The use of a floating LNG plant.

- The exportation of the discovered reserves through a pipeline to Turkey.

The first two options require the investment of significant amounts for the construction of the infrastructure and therefore they increase the risk of suffering major losses if the prices drop in the future and the production of the hydrocarbons become not viable.

Greece, Cyprus and Israel on January 2020 signed a deal for the construction of a pipeline connecting Israel and Cyprus energy fields with Europe through Greece.

EastMed, as the pipeline is called, is planned to have a capacity to transfer 9-12 billion cubic meters per year which is the equivalent of around 10% of Europe's annual needs of gas. The total cost of the pipeline is currently estimated over 6 billion euros. (Guggenheim, 2020)

Although EU and U.S support the efforts for the construction of the EastMed in an effort to diversify the energy sources for Europe there are concerns regarding the feasibility and economic viability of the pipeline.

In an interview in CNN Greece, Mr.Dimitris Fissas, Acting General Manager of the Cyprus Hydrocarbon Company, noted that the economic viability of East Med will be determined on how the European market will move in the next 5-6 years, the volume of natural gas that will be discovered and whether private companies and foreign countries will participate in the project (Kostas Pliakos, 2019)

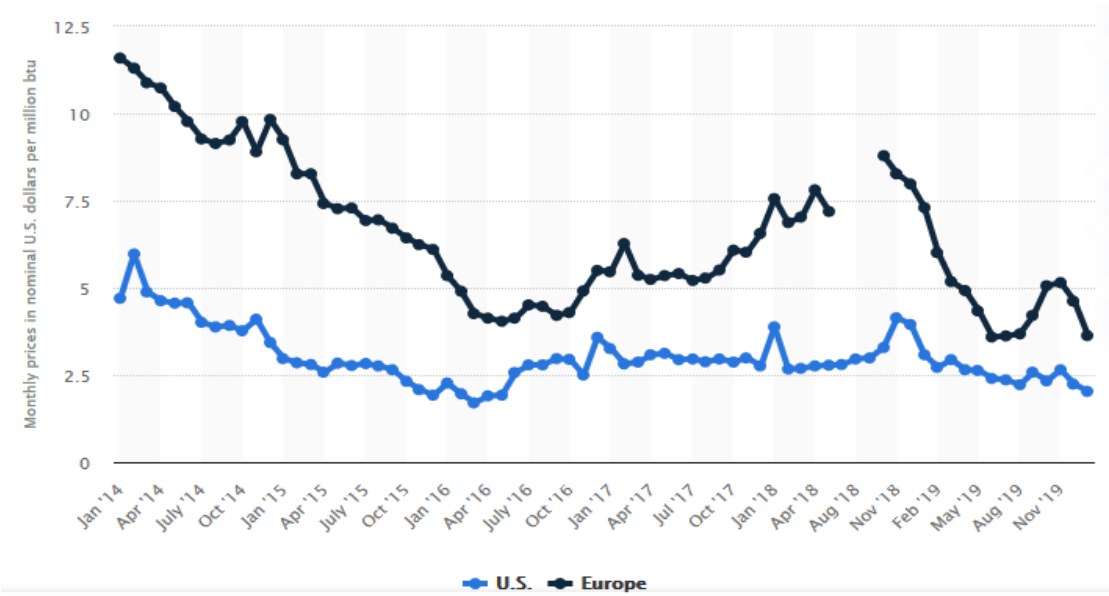

Diagram 3. Monthly prices for natural gas in the United States and Europe Source: www.statista.com

Mr.Ellinas in 2017 (Ellinas, 2017) have estimated that the cost of production from Aphrodite field will be $2-$2.5 per million BTU and another $3.5 per million BTU for transferring it through a pipeline. So this means that in order for the pipeline to be an economically viable solution prices should be over $6 dollar per million BTU. Based on the below diagram it can be noticed that since January 2016 the price of natural gas in Europe was for a significant period of time below that (Plecher, 2020).

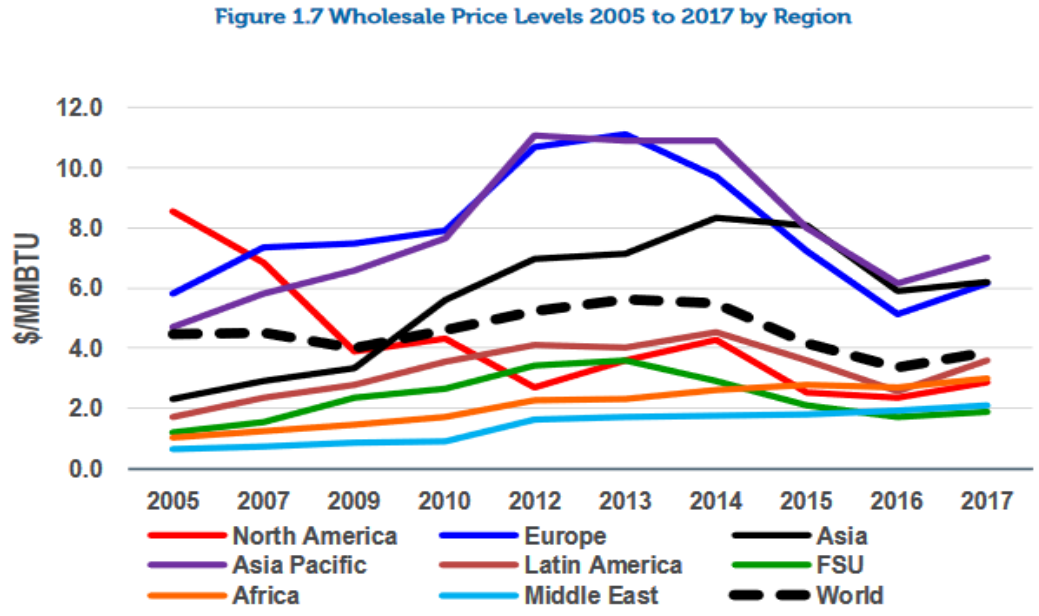

Diagram 4. Wholesale Prices Levels 2005 to 2017 for LNG. Source: IGU

Another disadvantage of the pipeline option is that if this option is chosen then Cyprus will not have much flexibility about the market it can sell the natural gas as the market will be limited only to Europe. Most if not all the reserves found in Cyprus EEZ will have to be sold through the pipeline to Europe. This limits the possibility from Cyprus to take advantage of possible markets were the natural gas prices are higher. As it can be seen in the above graph, markets in Asia and Asia Pacific sometimes have higher prices for LNG. (International Gas Union, 2018)

Another aspect that must be taken into consideration regarding the construction of the East-Med is that the pipeline is based on the fact that Cyprus and Greece EEZ will be connected without the interference of a third country's EEZ and therefore European Union will not be subject to political pressures from third countries. So far Greece has not declared its EEZ.

The possibility of constructing an LNG plant in Cyprus was an option that was considered the optimum option when the hydrocarbon exploration was first starting. This option will need a significant amount of investment and a significant amount of natural gas discoveries in order to be viable. The cost for the construction of the LNG Plant was estimated in 2013 to be between $6 billion to $9 billion (Ellinas, Cyprus on the Mend? Cyprus Energy Reserves, 2013). It is estimated that for the LNG Terminal to be economically viable 6 trillion cubic feet of natural gas will have to be discovered (Iacovos Kouppas, 2015). Another factor that must be considered is that the LNG plant in Cyprus it will have to compete with existing plants in Egypt and with this choice there will be little room for cooperation with Egypt. Egypt has already 2 LNG plants, the Idku and Damietta, that are under functioning due to the lack of sufficient quantities of natural gas (Reuters, 2020)On the other hand it is argued that a construction of such a plant in Cyprus would create a significant amount of jobs (ΑΝΑΔ, 2012) and could establish Cyprus as an energy hub in the region.

The Government of Cyprus signed an agreement with Egypt on 2018, which was then ratified by the House of Representatives on 2019, with the Egyptian Government for the construction of a pipeline connecting Aphrodite energy field with Egypt (Philelefθeros, 2019). This shows that the possibility of using the existing LNG plants in Egypt is a viable solution especially in the case of failing to discover significant quantities of natural gas that could justify the investment in the East Med or the LNG plant in Cyprus.

The potential sale of Cypriot Gas to Turkey would resulted in higher returns for Cyprus compared to the first two options, as it would require a relatively lower investment for constructing a pipeline connecting Cyprus with Turkey. This pipeline could be constructed much faster than EastMed and therefore Cyprus could start receiving revenue from its hydrocarbons much faster and therefore

boost its economy. This revenue could promote growth of the Cyprus economy and therefore the economic benefits from the early exploitation could be multiplied.

As it was discussed previously there are significant political issues between Cyprus and Turkey that make this option extremely difficult. Turkey do not recognise the Republic of Cyprus, a significant part of Cyprus's EEZ is claimed from Turkey either as its own or as part of the so called "Turkish Republic of Northern Cyprus" EEZ.

But even if the above obstacles could eventually be overcome, this option would give to Turkey an almost absolute control over the whole project.

Floating Liquefied Natural Gas (FLNG) is the most recent technological development in the offshore hydrocarbon exploitation sector. With this technology it is made possible to exploit, process, liquefy and store LNG on board. This process provides significant economic advantages as it is no longer necessary to construct long and expensive pipelines and onshore LNG plants.

There are no sufficient data, due to commercial confidentiality, of how much a FLNG vessel costs and in order to compare FLNG with onshore LNG plant has to be done on a project specific basis. (Rogers, 2016)

FLNG, as Rogers (2016) identifies, have the advantage that the can be available quicker than constructing onshore LNG plants and therefore the commercial exploitation of natural gas can start sooner. Another significant advantage is that FLNG vessels can be economically viable where expensive pipeline projects, like East Med, can be not.

On the other hand, it must be noted that the use of FLNG is considered to have higher risk of severe accidents, such as fires and explosions, than the onshore LNG plants (Haidar Ibrahim, 2017).

All of the above options have their advantages and disadvantages. Before deciding which option or options should be realised the political risks of each of these options will have to be assessed too.

Overall some significant points that are necessary to be taken in consideration are:

- Risk can be reduced by inviting third parties, such as private companies, to invest on the construction of high cost infrastructure. This would reduce the future potential income for the Republic, as it will have to share the profits with the investors, but in the case of a potential failure of the project, the economic effects will be manageable by the Republic.

- The significant delay of the project increases the risk that new green energy technologies or carbon reduction policies and regulations could reduce the global demand for fossil fuels and therefore the price of oil and gas. As previously explained this could be catastrophic for the economic viability of the project.

- As it shows in diagram 4, prices of natural gas can be significantly different from region to region. The ability of Cyprus to differentiate its targeted market may be the decisive factor of whether the project will be successful or not.

All of the above choices have also inherent risks relating to political issues.

Incident	Risk	Impact	Probability	Risk Level
Turkey Navy Blocks the ships from performing exploration and exploitation activities	Withdrawal of companies from the EEZ	High	Occasional	High
Armed conflict with Turkey	Cancellation of project until political solution	Catastrophic	Rare	High
Turkey performs exploration and exploitation activities in Cyprus EEZ	Cyprus hydrocarbon reserves been exploited by Turkey	High	Occasional	High

In an effort to mitigate those risks the Republic of Cyprus have to involve powerful players in order for Turkey to be more reluctant on taking more aggressive actions against Cyprus.

Another option is to try to come into an understanding with the Turkish Cypriot community regarding the exploitation of the hydrocarbons in Cyprus EEZ. Based on the previous research though, this could have a significant political cost to the government as 70% of the people asked were against of giving any portion of the revenue to the Turkish Cypriots before the solution of the Cyprus problem.

The option of postponing any activity until the resolution of the Cyprus problem could be a feasible option if the solution could be reached in a short period of time. In any other case this could cause significant delays that would put in significant risk the economic viability of the project if the estimation that prices in the future will be reduced due to new technologies as discussed previously.

The Republic of Cyprus could also use the potential benefits from the exploitation of the hydrocarbons to initiate an intensive effort to find a viable

solution to the Cyprus problem. The significant interest in the hydrocarbon project that major powers like the USA, France and the European Union have could give the needed attention and political pressure to all sites to come to a common understanding.

5.2.4 Cross Cutting Aspects for risks related to economic and political factors– Communication and Stakeholders Engagement

Incident	Risk	Impact	Probability	Risk Level
Low prices in the global market before the production stage begin	Project becoming non economically viable	Catastrophic	Rare	High
Low prices in the global market during the production life cycle stage	Project non-viable – Infrastructure becoming redundant	Catastrophic	Rare	High

As the oil and gas companies are major stakeholders regarding this risk the Republic will have to put in place a committee constantly observing how the energy market moves and be in constant communication with the oil and gas companies and if necessary amend the contracts. The House of Representatives will have to be also involved in the process as there may be the need to amend laws and regulations.

Incident	Risk	Impact	Probability	Risk Level
Armed conflict with Turkey	Cancellation of project until political solution	Catastrophic	Rare	High
Turkey Navy Blocks the ships from performing exploration and exploitation activities	Withdrawal of companies from the EEZ	High	Occasional	High
Turkey performs exploration and exploitation activities in Cyprus EEZ	Cyprus hydrocarbon reserves been exploited by Turkey	High	Occasional	High

The political environment is constantly changing and therefore the options are not static but they differentiate constantly. The Government of the Republic of Cyprus should aim to have the support of the majority of the political parties in Cyprus in its decisions. To achieve that it will have to include the political parties

in the decision making process. The Ministry of Foreign Affairs will have to constantly monitor the political developments in order to provide all the necessary information for the continual evaluation of all the available options.

5.3.1 Appraisal for risks related to environmental factors

Offshore Hydrocarbon exploration projects are usually separated in four (4) major life cycles.

- Exploration/Appraisal
- Development
- Production
- Decommissioning.

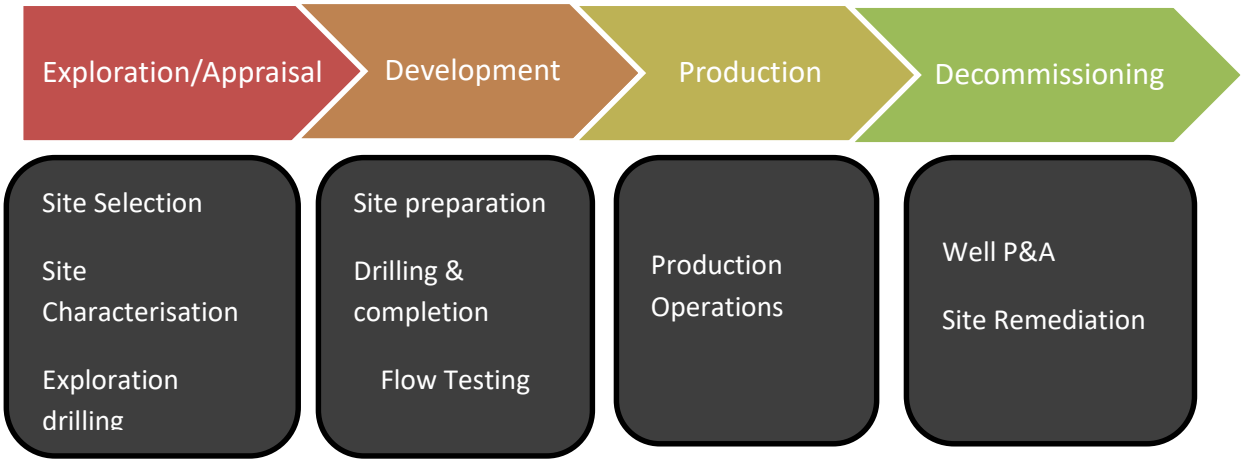

Diagram 5. Offshore Lifecycle phase Source: (European Commission, 2019)

Exploration/Appraisal lifecycle includes seismic surveys and well drilling. Locations for well drilling are decided after analysis of geological and geophysical information that were made available through the surveys. If the analysis of the data concludes that there are potentially economically viable hydrocarbon reserves, appraisal activities such as drilling and sampling are performed.

<u>Risk Related Activities in this stage are:</u>

-Seismic Surveys

-Data analysis

-Well drilling

-Transport of drilling rig

- Use of oil based mud and water based mud during drilling

- Handling of cuttings

- Cementing of well casing

- Clean up and introduction of completion fluids

Development includes the preparation plans for exploiting the hydrocarbon reserves. These plans include the number and type of wells, the design and type of facilities necessary and how the hydrocarbon reserves will be exported.

This life cycle includes the implementation of the above plans with the construction of all necessary facilities in order to proceed with production.

Risk Related Activities in this stage are:

-Preparation of plans

-Transport of drilling rig

- Positioning on seabed of the drilling rig

- Use of oil based mud and water based mud during drilling

- Handling of cuttings

- Cementing of well casing

- Clean up and introduction of completion fluids

Production life cycle includes all activities relating with the extraction of hydrocarbons from the seabed until the depletion of the hydrocarbon field.

Risk Related activities in this stage are:

-Chemical injections

-Processing of oil and gas

-Maintenance activities

-Waste management

-Off gas management – flaring

-Fuel and chemicals deliveries/loading

- Hydrocarbon and chemical storage

Decommissioning includes the activities relating to the cessation of production, the closure of the well and the decommissioning of the infrastructures.

Risk Related activities in this stage are:

- Well closure

-Management of cutting piles

-Topside and jacket decommissioning

-Decommissioning of seabed infrastructure and pipelines

-Long term well integrity

(European Commission, 2019) (European Commission, 2016)

The project faces several risks throughout the lifecycle of the project. For identifying risks, the life cycle and stages of a hydrocarbon exploration as presented in a study released by the European Commission in 2016 for assessing and managing environmentally related risks from exploring and production of hydrocarbons will be adopted.

Exploration/Appraisal

At this stage the activities can be divided into two sub stages

1. Desk studies and licensing
2. Exploratory Surveys

Desk Studies and licensing includes all necessary preparations for initiating the hydrocarbon exploration project. For the purposes of this master dissertation all activities and agreements regarding the delimitation of Cyprus EEZ is included in this sub stage.

Exploratory Surveys includes gravimetric and seismic surveys of the seabed and drilling of exploratory wells.

During the above activities there is the risk of that there will be an increase of the releases of air emission, such as sulphur oxides (SOx) , oxides of nitrogen (NOx) and volatile organic chemicals (VOCs), during all phases of the project.

Another risk is the generation of loud underwater noise during both the seismic survey and the exploratory drillings.

Environmental risks related to the drilling of exploratory wells for the purpose of this master dissertation will be presented in the next stage as they are the same as the risks to Development Stage with the drilling of the production wells. It

must be though emphasised that those risks will have to be managed during this stage of the project as well.

Development

The activities in this stage can be divided in the below sub-stages

1. Well Design
2. Transport of Drilling
3. Well Drilling
4. Well Completion

Well design includes the planning of the type of the well, the logistics and the construction of all necessary supporting onshore infrastructures. Bad or insufficient planning during this face is a risk that must be taken into consideration.

Transport of Drilling to the site can cause release of air emission and discharges to the sea.

Well drilling includes various steps that have some risks. First step is the positioning of the necessary machinery to the seabed in order to perform the drilling. This can cause seabed disturbance, underwater noise and introduction of foreign species to the marine environment.

The next step is the drilling of the well. This is performed with the use of water based mud (WBM) or oil based mud (OBM). This activity can cause seabed disturbance, increased air emissions, underwater noise and discharges to the marine environment.

Another step on this process is the handling of the drilling cuts which can cause discharge to the marine environment. Final step on well drilling is the cementing and casing of the well ensuring the integrity of the well with the introduction to the well cement, hardening and testing it before the drilling of the well continues. This activity can cause discharges to the marine environment and underwater noise.

Final sub stage for the Development is the Well completion.

Well completion includes the activities of well bore clean up and the introduction of completion fluids. Well is cleaned by removing any remaining muds, cuts and loose material with the use of water and solvents. This process can cause releases to the air due to flaring of excess gas and discharges to the sea.

The final step before the well is ready for production is the introduction to the well of completion fluids. These fluids prevent the build-up of microbes and creation of rust into the well thus protecting its integrity. The completion fluids

are made up from various chemicals solutions and the main risk in this step is the discharge of those chemicals into the environment.

Production

After the development procedures to the hydrocarbon field are completed the field enters the production stage. This stage covers all activities that are necessary for managing the flow of the hydrocarbons and the export of them through shipping vessels or pipelines. This stage can be divided to two separate sub-stages:

1) Platform installation
2) Platform Operations

Platform installation includes the activities of engineering, procurement and construction (EPC), the transportation of the platform, pilling for jacket, rock dumping, pre commissioning and the installation of the infrastructure to the seabed.

EPC activities include the planning, the management of the construction installations and the logistics. Incomplete or wrong information can cause bad or insufficient planning.

The transportation of the platform to the field can cause increased air releases.

Depending on the type and the nature of the hydrocarbon reservoir different types of platforms and seabed infrastructures and equipment will have to be installed which will need to be stabilized using various techniques and processes such as piling, gravity based rigs, suction cans/spud cans, rock dumping and tethering. The above activities can cause seabed disturbance, underwater noise, increased releases to air and discharge to the marine environment.

After the installation and stabilization processes are completed the project starts the pre-commissioning procedures. These procedures include the preparations of the systems and the final checks such as hydrostatic leaking test. These activities can cause discharges to the marine environment.

The installation of seabed production infrastructure such as electrical and hydraulic pumps, pipelines, valves and other equipment can cause seabed disturbance and underwater noise.

Platform operations includes the activities of chemical injections, subsea production systems, oil and gas processing and handling, water and sand management, off-gas management, power generation and combustion equipment, the storage of hydrocarbons and chemicals, the delivery of fuel and chemicals, heat, ventilation and air conditioning, waste management, gas export pipeline equipment, enhanced recovery and well stimulation. The aboce

activities can cause discharge to the marine environment cause seabed disturbance, underwater noise, increased releases to air and changes on the seabed structure.

Project cessation and well closure

The final stage in the life cycle of a hydrocarbon exploration project is the cessation of the activities and the closure of the well.

After the hydrocarbon reservoir is depleted and the production is ceased the infrastructures that were constructed on the site will have to be decommissioned and the well to be closed. This stage can be divided to 2 sub stages.

1) Well Closure
2) Management of cutting piles

The well closure is done in order to prevent any hydrocarbons that were left on the reservoir to be introduced into the sea. The well closure includes the flooding of the well with sea water and the construction of a plug that is usually made out of cement. The above activities can cause discharges to the marine environment, underwater noise and disturbance to the seabed.

Management of cutting piles includes two options, either leaving the installations in the site or removing them. Removal can be done by excavating the pile and recovering it to the surface or transferring them to another location in the seabed. These activities can cause discharges to the sea environment, seabed disturbance and increased air emissions.

5.3.2 Characterisation and evaluation for risks related to environmental factors

Exploration/Appraisal

Seismic Surveys

The use of shipping vessels for performing the surveys is unavoidable. The releases to the air can have two impacts. First the deterioration of the air quality on a local level and second the increase of greenhouse gas emissions that affect the environment as a whole.

Except of some environmental organisations the occurrence of such incidence seems to be of low concern to other stakeholders.

These incidents can occur occasional with the impact being slight. Therefore the risk is considered low.

Incident	Risk	Impact	Probability	Risk Level
Air emissions	Reduction of air quality locally	Trivial	Occasional	Low

During the seismic surveys the vessels use acoustic waves to obtain valuable information which will help to identify the presence of oil and gas in the area. The use of sonar technology can cause injuries to marine species (Reynolds, 2008) which are protected under the European directive 92/43/EEC.

The seal Monachus monachus, turtle caretta caretta and chelonian mydas as also the dolphin tursiops truncates are some of the protected species that are found in the sea around Cyprus. (Audit Office of the Republic of Cyprus, 2018)

The protection of those species is significant for environmental organisations and a significant proportion of the public and the injury of such creatures could have a negative effect to the whole project.

Also the Republic has the obligation to protect those species based on international and European Treaties such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on the conservation of European wildlife and natural habitats (Bern Convention). (MOA Department of Environment, 2020)

The probability that the activity will cause injuries to marine creatures and especially to protected species is rare while the impact of such incident is considered medium. Therefore the overall risk is classified as medium.

Data analysis

Not correct data analysis may lead to unsuccessful test well drilling which can cause unnecessary environmental damage, can cause economic cost and a significant number of unsuccessful well drilling could also cause some companies to not get involved or withdraw from the project.

Well Drilling

The well drilling procedure starts with the transportation of the drilling rig to the site. The transportation will unavoidable be done with the use of fuels which will cause releases to the air. This can have the same effects as previously discussed in the seismic survey stage.

Incident	Risk	Impact	Probability	Risk Level
Air emissions	Reduction of air quality locally	Trivial	Occasional	Low

The next step is the positioning of the equipment to the seabed in order to proceed with the exploratory drilling.

The positioning of the equipment to the seabed can cause seabed disturbance which can cause damage to the local environment, underwater noise produced during the drilling process can cause disturbance to the marine fauna.

Incident	Risk	Impact	Probability	Risk Level
Seabed disturbance from positioning of the equipment	Damage to local marine environment	Trivial	Highly likely	Medium
Underwater noise from positioning of the equipment	Injury of marine fauna	Small	Likely	Medium

The above risks are tolerable but certain measures will have to be put in place in order to mitigate the risks.

Another risk during the positioning of the equipment is the introduction of foreign species to the environment. This can be done from species that were attached to the equipment during previous drills in other locations. There are increased chances of introducing new species to the environment the impact of which will be small. The risk is considered to be medium.

Incident	Risk	Impact	Probability	Risk Level
Introduction of foreign species from positioning the equipment	Damage to local marine environment	Small	Likely	Medium

Development

The next step to the project is the drilling of the well itself. This is done with the use of water based mud and oil based mud, depending on the geological characteristics of the location.

This activity could cause seabed disturbance which could lead to damaging the local marine environment. The impact of such event to the project is trivial with probability deemed occasional and therefore the risk is classified as low.

Incident	Risk	Impact	Probability	Risk Level
Seabed disturbance	Damage to local marine environment	Trivial	Occasional	Low

Another risk linked to the certain activity is the release of emissions to the environment and the production of underwater noise. Those risks are the same as discussed in the previous steps with the risk categorised as low.

Incident	Risk	Impact	Probability	Risk Level
Air emissions	Reduction of air quality locally	Trivial	Likely	Low
Seabed disturbance	Damage to local marine environment	Trivial	Rare	Low

This activity could also cause discharges to the marine environment either deliberate, as part of the drilling process, or non-deliberate, after an accident.

During the drilling process a small amount of discharges containing chemicals can be dispersed to the environment. The small volume of those chemicals and the dilution of them in the water reduce the impact of those chemicals to the environment to trivial levels. The risk of this is categorised as low.

Incident	Risk	Impact	Probability	Risk Level
Discharges of chemicals to the marine environment during the normal operations of the drilling rig	Impact on the marine ecosystem	Trivial	Occasional	Low

Also here risk is evaluated as low and therefore will be treated as acceptable and no risk reduction is considered necessary.

Discharges of large amounts of chemicals or oil due to an accident though can cause significant damage to the marine environment. The impact of such event in the marine ecosystem could be catastrophic. The discharges could also affect the coastline and the local communities. Although that the probability of such

accident occurring is rare the level of impact that the incident would have in the project is of such importance that the risk is categorised as high.

Incident	Risk	Impact	Probability	Risk Level
Discharges of chemicals to the marine environment due to accident	Impact on the marine ecosystem	Catastrophic	Rare	High

Discharges of large amounts of chemicals and oil could potentially have catastrophic results to the tourism industry if those chemicals and oils reach the coastline. The tourism industry in Cyprus is a significant sector, in 2017 14% of the country's GPP was generated by the tourism industry and the sector is keep growing. (Cyprus Tourism Organisation, 2018). A significant amount is spent each year for advertising Cyprus as a quality tourist destination. A major accident could destroy the identity of Cyprus, especially as a summer holiday destination.

Incident	Risk	Impact	Probability	Risk Level
Discharges of chemicals to the marine environment due to accident	Impact on the tourist industry	Catastrophic	Rare	High

<u>Handling of cuttings</u>

During the drilling procedure drilling cuts will be generated that will be brought to the surface. These drilling cuts can be contaminated with residues of the drilling mud and traces of hydrocarbons. Discharges of drilling cuts to the environment could potentially affect the marine ecosystem. The impact of such event is minor and risk is categorised as low.

Incident	Risk	Impact	Probability	Risk Level
Discharge of drilling cuts to the sea	Impact on the marine ecosystem	Trivial	Occasional	Low

During the drilling process which is done in phases a steel case is cemented in place to enhance the integrity of the well. During this process cement is pumped from the surface to the well. This procedure could cause discharges to the sea environment that could cause damages to the marine environment. The impact

of such event is considered trivial with the probability been characterised as occasional, therefore the risk is categorised as low.

Incident	Risk	Impact	Probability	Risk Level
Discharge of drilling cuts to the sea	Impact on the marine ecosystem	Trivial	Likely	Low

After the Completion of the drilling the well has to be cleaned in order to remove remaining muds, cuttings and other materials left inside the well. For the cleaning process a number of chemicals, such as solvents and surfactants, are used. The impact of discharges to the sea of chemicals used during this process is considered small and the probability of occurring is occasional. The risk is classified as low.

Incident	Risk	Impact	Probability	Risk Level
Discharge of chemicals to the sea	Impact on the marine ecosystem	Trivial	Occasional	Low

Production

Platform installation

The risk associated with this activity is the releases to the air. The risks are the same as described on the transportation of the drilling rig process. The risk is low.

Incident	Risk	Impact	Probability	Risk Level
Air emissions from transporting the Platform	Reduction of air quality	Trivial	Occasional	Low

The installation of the platform will occasionally have an impact on the seabed which will have a trivial impact and therefore the risk is low. The underwater noise from this activity which can cause disturbance to the animals is also considered to be of trivial impact to the project. Similar to the previous stages the platform installation will produce increased releases to the air which again is considered a low risk.

During the platform installation a loss chemicals like hydraulic fluids is another risk that it must be considered. The loss of such fluids could have a small impact to the marine environment but the probability of this occurring is not high. The risk is also low.

Incident	Risk	Impact	Probability	Risk Level
Seabed disturbance	Damage to local marine environment	Trivial	Occasional	Low
Underwater noise	Disturbance of marine fauna	Trivial	Likely	Low
Air emissions	Reduction of air quality	Trivial	Likely	Low
Discharge of chemicals to the sea	Impact on the marine ecosystem	Small	Rare	Low

Platform operations

The risks related to this activity are the contamination of the sea due to the release of chemicals used during the process in the marine environment. There is very low probability of this happening with a small impact to the project. The risk is categorised as small.

Incident	Risk	Impact	Probability	Risk Level
Discharge of chemicals to the sea	Impact on the marine ecosystem	Small	Rare	Low

An accident leading to the contamination of the sea or the air with hydrocarbons is another risk that is identified during this process. The release of large quantities of oil in the sea environment can have catastrophic impact for the project. There are no evidences so far of oil reserves in Cyprus EEZ while the release of gas to the environment is considered to be of less impact.

Incident	Risk	Impact	Probability	Risk Level
Discharge of oil to the sea	Impact on the marine ecosystem and the coast	Catastrophic	Rare	High
Discharge of gas to the environment	Impact on the environment	High	Rare	Medium

During the production of hydrocarbons water and sand waste is produced. Water waste contains oil and gas and it must be managed in order not to contaminate the environment. Sand produced during the well operation may cause problems to the equipment.

Discharge of untreated water to the environment can cause loss of marine biodiversity and damage to the coastline. It is rare for such event to occur and its

impact relating to the environment is classified as small. Therefore the risk is low.

Incident	Risk	Impact	Probability	Risk Level
Discharge of untreated water and sand to the sea	Impact on the marine ecosystem and the coastline	Small	Rare	Low

Another risk are during this phase of the project is the storage of fuels on the platform for producing the required energy to operate the platform. The platform's increased energy needs means that there is the need to storage large quantities of fuel. An accident that would cause the discharge of these fuels to the sea could have high impact on the marine ecosystem and the nearby coastline. Such events are extremely rare and therefore the risk is categorised as low.

Incident	Risk	Impact	Probability	Risk Level
Discharge of fuel to the sea	Impact on the marine ecosystem and the coastline	High	Extremely Rare	Low

The delivery of fuels and chemicals necessary for the operation of the platform can also be a source of risk. An accident during the delivery could cause spill of chemicals or fuels to the sea causing damage to the marine environment. The probability of such incident is rare and the impact is small. Therefore the risk is categorised as low.

Incident	Risk	Impact	Probability	Risk Level
Discharge of chemicals and fuels to the sea	Impact on the marine ecosystem and the coastline	Small	Rare	Low

The hydrocarbons extracted from the field can be transferred from the platform either with tanker ships or by pipelines. Each of these options has its own risks.

The transfer with the use of tanker ships requires that the ships held in place for several hours during the transfer of the hydrocarbons. This increases the risks of an accident causing the leaking of hydrocarbons into the sea with high impact on the environment. Such incidents are considered to be extremely rare and therefore the risk is low.

Incident	Risk	Impact	Probability	Risk Level
Discharge of hydrocarbons in the sea	Impact on the marine ecosystem and the coastline	Major	Extremely Rare	Low

Alternatively a pipeline will have to be constructed connecting the well with the shore in order for the hydrocarbons to be transferred. The construction itself of the pipeline has its own risks which will not be covered in this master dissertation. A risk relating with the transfer of the hydrocarbons through a pipeline is that a failure and rupture of the pipeline would cause a massive amount of hydrocarbons to be discharged to the sea causing severe damage to the marine environment and the coastline. The severity of the impact in such an event would be catastrophic. The probability of such incident is rare and so the risk is categorised as high. It must be noted that in the case of gas exported through the pipeline the impact of such a failure is small.

Incident	Risk	Impact	Probability	Risk Level
Discharge of hydrocarbons(oil) in the sea due to failure of the pipeline	Impact on the marine environment and the coastline	Catastrophic	Rare	High
Incident	Risk	Impact	Probability	Risk Level
Discharge of hydrocarbons(gas) in the sea due to failure of the pipeline	Impact on the marine environment and the coastline	Small	Rare	Low

Decommissioning

During the last stage of the project which includes the well closure and the management of the cuttings the risk of discharges to the sea, underwater noise and physical disturbance of the seabed have a trivial impact and low probability of occurring. Therefore they are categorised as low risk.

Incident	Risk	Impact	Probability	Risk Level
Seabed disturbance	Damage to local marine environment	Trivial	Occasional	Low
Underwater noise	Disturbance of marine fauna	Trivial	Rare	Low
Discharge of chemicals to the sea	Impact on the marine ecosystem	Trivial	Rare	Low

After the closure and plugging of the well there is a risk that the integrity of the well will fail over time causing a leakage of hydrocarbons to the sea. The probability of such event is extremely rare and the risk is categorised as low.

5.3.3 Management of risks related to environmental factors

Exploration/Appraisal

Seismic Surveys

Incident	Risk	Impact	Probability	Risk Level
Underwater noise	Injury of marine fauna	Medium	Rare	Medium

As the risk is evaluated as medium this is a tolerable risk but risk mitigation strategies have to be taken to reduce the risk.

The area where seismic surveys are planned to take place they should be inspected before that to identify if the area is inhabited by any protected species. Efforts must be taken to prevent any seismic surveying operations during the breeding season of those protected species.

Another risk reduction strategy is the implementation of the "soft-start" method. This method requires from the operators of the seismic survey equipment to begin with low energy pulses which are then gradually increased to operational levels energy pulses. This method provides sufficient warning and time for any protected species that are in the area to leave without sustaining any injuries (Joint Nature Conservation Committee, 2017).

Well Drilling

Incident	Risk	Impact	Probability	Risk Level
Seabed disturbance from positioning of the equipment	Damage to local marine environment	Trivial	Highly likely	Medium
Underwater noise from positioning of the equipment	Injury of marine fauna	Small	Likely	Medium

The above risks are tolerable but certain measures will have to be put in place in order to mitigate the risks.

In order to reduce the seabed disturbance from the positioning of the rig methods like optimising the mapping of the anchoring points so they can be reused by vessels and the rig and also avoiding to place rigs to protected areas (Genesis Oil & Gas Consultants Ltd, 2011). Another method for reducing the risk is using a guided pipe when dumping rocks for securing the rig for accurate placement of the rocks to the seabed.

The measures necessary for reducing the risk of underwater noise are the same as the ones previously discussed in the seismic survey stage.

Introduction of foreign species from positioning the equipment	Damage to local marine environment	Small	Likely	Medium

As the introduction of foreign species could have a negative effect in the local species and especially fishes and other marine species with commercial value and therefore have a negative effect on the economic activities of fishers in Cyprus, the risk will have to be reduced.

For reducing the risk of introducing foreign species to the environment the operators must ensure that water in ballast tanks will be only loaded and discharged to the sea at the well site.

Development

Discharges of large amounts of chemicals or oil due to an accident though can cause significant damage to the marine environment. The impact of such event in the marine ecosystem could be catastrophic. The discharges could also affect the coastline and the local communities. Although that the probability of such accident occurring is rare the level of impact that the incident would have in the project is of such importance that the risk is categorised as high.

Incident	Risk	Impact	Probability	Risk Level
Discharges of chemicals to the marine environment due to accident	Impact on the marine ecosystem	Catastrophic	Rare	High

Incident	Risk	Impact	Probability	Risk Level
Discharges of chemicals to the marine environment due to accident	Impact on the tourist industry	Catastrophic	Rare	High

The risk is tolerable as it cannot be avoided. Significant measures will have to be taken in order to reduce the risk.

Such measures will include the preparation for each individual drill site specific oil spill models, emergency plans which will include clean up procedures and dedicated response crew that will be available to respond immediately if such incident occurs.

Also the operators of the drilling rig will have to use Blow-Out Preventers and well kill technology, where heavy fluids will be available to be introduced to the well in an event of unexpected increase of pressure inside the well.

Production

Platform operations

Incident	Risk	Impact	Probability	Risk Level
Discharge of oil to the sea	Impact on the marine ecosystem and the coast	Catastrophic	Rare	High
Discharge of gas to the environment	Impact on the environment	High	Rare	Medium

The risks are tolerable as it cannot be avoided. Significant measures will have to be taken in order to reduce the risk.

The measures that must be taken are the same as the ones described in the development stage of the project.

Incident	Risk	Impact	Probability	Risk Level
Discharge of hydrocarbons(oil) in the sea due to failure of the pipeline	Impact on the marine environment and the coastline	Catastrophic	Rare	High
Discharge of hydrocarbons(gas)	Impact on the marine	Small	Rare	Low

in the sea due to failure of the pipeline	environment and the coastline			

The risk is tolerable but significant measures will have to be put in place to reduce the risk.

Those measures are the same as the ones discussed in the development stage. Additional measures are the installation of quick release valves, leak detection system and also a frequent maintenance program must be in place. The use of robotic devices that are used for inspecting the pipelines and can help with the indication of possible defects in the pipeline and therefore help with taking precautionary measures (Devold, 2013)

5.3.4 Cross Cutting Aspects for risks related to environmental factors – Communication and Stakeholders Engagement

Exploration/Appraisal

Seismic Surveys

Incident	Risk	Impact	Probability	Risk Level
Air emissions	Reduction of air quality locally	Trivial	Occasional	Low

In order to monitor the air emissions, a carbon footprint calculation could be developed which would provide a useful monitor and control tool for the management of that risk. Proper logistics could also be considered as to minimise the required shipping journeys (Antrim Energi, 2014).

The data collected from the carbon footprint calculation tool would be useful to be communicated in a regular manner through an annual report so that stakeholders, such as environmental groups, can be included in the process.

Incident	Risk	Impact	Probability	Risk Level
Underwater noise	Injury of marine fauna	Medium	Rare	Medium

In an annual report all the steps taken for the management of this risk will be detailed documented and presented to the public. The report except the risk mitigation measures will have to include scientific reports that will evaluate the populations of all the protected species as to monitor and control whether the risk mitigation strategies have had the expected results.

Well Drilling

Incident	Risk	Impact	Probability	Risk Level
Air emissions	Reduction of air quality locally	Trivial	Occasional	Low

Same communication strategy as the one described in the seismic survey risk of air emissions should be followed here too.

Incident	Risk	Impact	Probability	Risk Level
Seabed disturbance from positioning of the equipment	Damage to local marine environment	Trivial	Highly likely	Medium
Underwater noise from positioning of the equipment	Injury of marine fauna	Small	Likely	Medium

Environmental studies should be prepared and published where the impact of this activity will be analysed and explained to the public along with a scientific estimation for the time it will need for the environment to be restored to its previous condition.

Introduction of foreign species from positioning the equipment	Damage to local marine environment	Small	Likely	Medium

A committee with the participation of professional fishermen, environmental groups, environmental department and the Department of Fisheries and Marine Research should be established that would continually monitor the impact of the project in the marine environment and more specifically with the fish stock numbers.

Development

Incident	Risk	Impact	Probability	Risk Level
Seabed disturbance	Damage to local marine environment	Trivial	Occasional	Low

Communication strategy as the one analysed on the well drilling stage can be applied here too.

Incident	Risk	Impact	Probability	Risk Level
Air emissions	Reduction of air quality locally	Trivial	Likely	Low
Seabed disturbance	Damage to local marine environment	Trivial	Rare	Low

Same communication strategy as the one described in the seismic survey risk of air emissions and seabed disturbance in the well drilling stage should be followed here too.

5.4 Risk Registry

All the identified risks are recorded on a risk registry (Appendix B) as to be constantly monitored and re-evaluated during the project. If new information or new events change their evaluation either because of the impact they may cause or because of the probability then the risk management measures will have to be re-evaluated as well.

Chapter 6
Conclusions

The hydrocarbon exploration and exploitation project is very big and complex by its nature. This master dissertation addresses the management of risks related with political, economic and environmental factors.

The most significant risks that are related to environmental factors are the ones which involve the spillage of chemicals and oil to the sea. This could cause severe damage to the marine environment and the coastline. Based on the risk analysis this would have a catastrophic impact to the project.

The Republic of Cyprus should not solely rely on the oil and gas companies for managing this risk. The involvement of international organisations that are specialized in the conservation of the environment in the process could be useful for minimizing these kinds of risks of materializing. Emergency plans made specific for each individual drill site must be prepared. This emergency plans have to include clean up procedures and dedicate response crew that will be available to respond immediately. The crew members must be well trained with regular emergency simulations and drills.

Risks relating to economic factors have to do with the global oil prices which have a positive correlation to the price of natural gas. A reduction of prices in the global market could have catastrophic impact on the project as it could make some options or even the whole project financially non-viable.

Based on the risk analysis this risk is time sensitive and therefore the Republic of Cyprus should pursue to the exploitation of the hydrocarbons as soon as possible.

Perhaps the most significant risk and the one which is the most complicated to be managed is the risks relating to political factors. The unpredictability of Turkey along with the large number of stakeholders such as other countries and organisations with opposed, interlinked and in many cases constantly changing interests demands that the risk management process to be constantly monitored and evaluated. The risk of having an armed conflict with Turkey although it is evaluated as not probable it would have a catastrophic impact for the project.

The risks involved in this project transcend the limits of the project success or failure. Risks that are inherent to the project could have catastrophic

consequences to other sector of the economy, such as the tourist industry, in the case of a major environmental catastrophe. More over political risks such as the risk of an armed conflict could have catastrophic impact to the whole Cyprus economy and society. These consequences would have long lasting effects that could be irreversible and change the lives of Cypriot citizens for life.

Although it is understood that some elements and details of the project includes significant and very sensitive information on political and economic level, the public should be able to have access to the information regarding policies, procedures and regulations that are in place to manage this project and how the various risks are identified, evaluated and managed.

The fact that there are no publicly available information regarding the steps that the Government of Cyprus is taking for risk management of the oil and gas project means that people cannot evaluate if their interests are been represented in the most efficient and effective manner and cannot be involved as one of the most, if not the most, important stakeholder of the project. A better balance between transparency and the need of protecting state secrets should be reached.

The implementation of a risk management framework could help in this effort. It would illustrate to the public that the Government has acknowledged that this project needs proper risk management and is taking all the necessary steps to manage those risks.

The implementation would help put in place procedures where all stakeholders could be involved in raising their views and their concerns regarding the project.

The latest events with the pandemic of Covid-19 along with the price war between Saudi Arabia and Russia (European Council on Foreign Relations, 2020) have created the perfect storm in the oil and gas markets. Prices have plunged to the lowest levels of the last 20 years (Financial Times, 2020). Although the pandemic could be described as a “black swan” the price war and the resulting crash of the oil and gas prices was something that was identified in this thesis dissertation as a high risk that could have a catastrophic impact on the project.

This evaluation it seems to be realising as Exxon Mobil have already announced the cancellation of all its activities in Cyprus EEZ for at least until September 2021. The energy minister Mr Lakkotrypis has confirmed that he was informed by the company that they will postpone their activities and he also said that there is a high probability that other companies will follow Exxon Mobil in the next few weeks (Cyprus-Mail, 2020).

Those events have made even clearer the importance of Risk Management for this project. At this point is estimated that the Republic will not suffer damages that cannot manage as the exploration drillings were performed by the companies without any capital commitments by the Republic.

If the project was a few steps ahead and the Republic had already invested significant capital in the construction of infrastructures or its public economics were partly based on the revenues from the sale of the hydrocarbons it could cause extremely negative impact to Cyprus.

Appendix A

As of today the Republic of Cyprus has granted the following exploration license and the following activities have taken place:

Block 2 – Granted in January 2013

- ENI Cyprus Limited (60%) - «Operator »
- KOGAS Cyprus Limited (20%)
- TOTAL E&P Cyprus BV (20%)

Block 3 – Granted in January 2013

- ENI Cyprus Limited (50%) - «Operator »
- KOGAS Cyprus Limited (20%)
- TOTAL E&P Cyprus BV (30%)

The companies are on the initial exploration period with 2-D and 3-D seismic surveys performed.

Block 6 – Granted in April 2017

- ENI Cyprus Limited (50%) - «Operator »
- TOTAL E&P Cyprus BV (50%)

On February 2018 the exploration well on "Calypso-1" was completed. The data from the well and the initial analysis indicated extensive natural gas reserves. Further geological and geophysical studies are necessary to evaluate the total quantity of natural gas in the field.

Block 7 – Granted in September 2019

- TOTAL E&P Cyprus BV (50%) - «Operator»
- ENI Cyprus Limited (50%)

Block 8 – Granted in April 2017

- ENI Cyprus Limited (60%) - «Operator»
- TOTAL E&P Cyprus BV (40%)

The companies are on the initial exploration period with 2-D and 3-D seismic surveys performed.

Block 9 – Granted in January 2013

- ENI Cyprus Limited (60%) - «Operator »
- KOGAS Cyprus Limited (20%)
- TOTAL E&P Cyprus BV (20%)

In 2014 the exploration well "Onasagoras-1" and in 2015 the exploration well "Amathusa-1" were completed. The results of both wells showed no economical viable reserves of natural gas.

Block 10 – Granted in April 2017

- ExxonMobil Exploration and Production Cyprus (Offshore) Limited (60%) - «Operator »
- Qatar Petroleum International Upstream LLC (40%)

On January 2019 the exploration well "Delphyne-1" was completed without finding any substantial reserves of natural gas.
On February 2019 the exploration well "Glaucus-1" was completed. Based on the data from the exploration well and the initial analysis is estimated that there are between 5-8 tcf of natural gas reserves in the reservoir.
Block 11 – Granted in February 2013

- TOTAL E&P Cyprus BV (50%) - «Operator»
- ENI Cyprus Limited (50%)

The consortium is on its second renewal of the license. On September 2017 the exploration well "Onesiphoros West-1" was completed without finding any exploitable reserves of natural gas.

And also the Republic of Cyprus has granted an exploitation license as follow:
Block 12 (Aphrodite) – Granted in November 2019

- Noble Energy International Ltd (35%) - «Operator »
- Delek Drilling Limited Partnership (30%)
- BG Cyprus Limited (35%)

The exploration well “Cyprus A-1” in 2011, the second confirmatory well “Cyprus A-2” and a production test performed in 2013 validated the presence of the reservoir “Aphrodite” with 4.5tcf of natural gas. The field was declared commercially viable on January 2015.
(Cyprus Hydrocarbon Company (CHC), 2017)

Appendix B
Registrar of Risks

Political/Economical

Incident	Risk	Impact	Probability	Risk Level
Low prices in the global market before the production stage begin	Project becoming non economically viable	Catastrophic	Rare	High
Low prices in the global market during the production life cycle stage	Project non-viable – Infrastructure becoming redundant	Catastrophic	Rare	High
Armed conflict with Turkey	Cancellation of project until political solution	Catastrophic	Rare	High
Turkey Navy Blocks the ships from performing exploration and exploitation activities	Withdrawal of companies from the EEZ	High	Occasional	High
Turkey performs exploration and exploitation activities in Cyprus EEZ	Cyprus hydrocarbon reserves been exploited by Turkey	High	Occasional	High

Environmental

Exploration/Appraisal

Incident	**Risk**	**Impact**	**Probability**	**Risk Level**
Seismic Surveys				
Air emissions	Reduction of air quality locally	Trivial	Occasional	Low
Underwater noise	Injury of marine fauna	Medium	Rare	Medium
Incident	**Risk**	**Impact**	**Probability**	**Risk Level**
Transportation of the drilling rig				
Air emissions	Reduction of air quality locally	Trivial	Occasional	Low
Positioning of the equipment to the seabed				
Seabed disturbance	Damage to local marine environment	Trivial	Highly likely	Medium
Underwater noise	Injury of marine fauna	Small	Likely	Medium
Introduction of foreign species	Damage to local marine environment	Small	Likely	Medium

Development

Incident	Risk	Impact	Probability	Risk Level
Drilling of the well				
Seabed disturbance	Damage to local marine environment	Trivial	Occasional	Low
Air emissions	Reduction of air quality locally	Trivial	Likely	Low
Seabed disturbance	Damage to local marine environment	Trivial	Rare	Low
Discharges of chemicals to the marine environment during the normal operations of the drilling rig	Impact on the marine ecosystem	Trivial	Occasional	Low
Discharges of chemicals to the marine environment due to accident	Impact on the marine ecosystem	Catastrophic	Rare	High

Handling of cuttings				
Discharge of drilling cuts to the sea	Impact on the marine ecosystem	Trivial	Occasional	Low
Steel case cemented				
Discharge of drilling cuts to the sea	Impact on the marine ecosystem	Trivial	Likely	Low
Cleaning of the well				
Discharge of chemicals to the sea	Impact on the marine ecosystem	Trivial	Occasional	Low

Production

Incident	Risk	Impact	Probability	Risk Level
Platform installation				
Air emissions	Reduction of air quality	Trivial	Occasional	Low
Incident	Risk	Impact	Probability	Risk Level
Seabed disturbance	Damage to local marine environment	Trivial	Occasional	Low
Underwater noise	Disturbance of marine fauna	Trivial	Likely	Low
Air emissions	Reduction of air quality	Trivial	Likely	Low
Discharge of chemicals to the sea	Impact on the marine ecosystem	Small	Rare	Low
Platform operations				
Discharge of chemicals to the sea	Impact on the marine ecosystem	Small	Rare	Low
Incident	Risk	Impact	Probability	Risk Level
Discharge of oil to the sea	Impact on the marine ecosystem and the coast	Catastrophic	Rare	High
Discharge of gas to the environment	Impact on the environment	High	Rare	Medium
Discharge of untreated water and sand to the sea	Impact on the marine ecosystem and the coastline	Small	Rare	Low

Delivery and storage of fuels and chemicals on the platform				
Discharge of fuel to the sea	Impact on the marine ecosystem and the coastline	High	Extremely Rare	Low
Discharge of chemicals and fuels to the sea	Impact on the marine ecosystem and the coastline	Small	Rare	Low
Transfer of extracted hydrocarbons (Pipeline or Tanker ships)				
Discharge of hydrocarbons in the sea	Impact on the marine ecosystem and the coastline	Major	Extremely Rare	Low
Discharge of hydrocarbons(oil) in the sea due to failure of the pipeline	Impact on the marine environment and the coastline	Catastrophic	Rare	High
Discharge of hydrocarbons(gas) in the sea due to failure of the pipeline	Impact on the marine environment and the coastline	Small	Rare	Low

<u>Decommissioning</u>

Incident	Risk	Impact	Probability	Risk Level
Well closure				
Seabed disturbance	Damage to local marine environment	Trivial	Occasional	Low
Underwater noise	Disturbance of marine fauna	Trivial	Rare	Low
Discharge of chemicals to the sea	Impact on the marine ecosystem	Trivial	Rare	Low

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