



# Master's degree thesis

**LOG950 Logistics**

**Reducing the environmental footprint by back-shoring manufacturing? To what extent could European production outperform Asian production with respect to climatic impact? The case of offshore crane manufacturing.**

**Hanna Janina Hjelvik**

**Number of pages including this page: 149**

**Molde, 22.05.2023**



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## **Preface**

This master thesis is written as the final requirement by Hanna Janina Hjelvik who is studying for a master's in Logistics Analytics for a master's degree at the Molde University College – Specialized University in Logistics.

This thesis represents an independent and extensive piece of research conducted under the supervision of Professor Harald Martin Hjelle.

## **Acknowledgement**

This master's thesis would not have been accomplished without uncompromising support of some people and I am deeply grateful for each one of you.

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A special gratitude to Bjørnar Avsett and NOV company for so kind response to my request for collaborating with me on my master thesis project. I am sincerely grateful for helping me and participating during the whole project.

Finally, I would like to thank all respondents who agreed to be a part of my project. Thank you for your time and willingness to share invaluable information with me which provided me with insights and information of great use.

## **Abstract**

Increasing concern about global climate change and carbon emissions as a causal factor are the reasons for companies pursuing “carbon footprint” projects to monitor their contribution to global climate change. (H. Scott Matthews, et al, 2008)

This study seeks to identify the potential for a more sustainable manufacturing of cranes by comparing the footprint of production in South Korea to a European venue.

Backshoring (reshoring) i.e the reversal of offshoring strategies refers to the company’s decision to bring previously offshored manufacturing activities back or closer to the home country, has become a key theme in the industrial location literature.

This thesis investigates the interdependence between backshoring, environmental sustainability and supply chain through a case study of a crane manufacturer NOV.

The NOV company aspire to be a proactive actor in the market, they would like to be ahead of and implement documentation which could contribute to the common goal to limit and preferably stop emissions GHG emissions.

Requirements for environmental acceptability have recently risen and demands of the stakeholders are based on transparency and visibility.

Logistic providers, transport operators, freight forwarders will need clear, global, and transparent CO2 calculation. (Wild P. ,2021)

The study uses a survey method consisting of expert interviews and literature review to approach the research problem. The findings of the study show that backshoring may be a good solution in times of disruption, but that actual implementation is still challenging.

The findings from the study are used to develop models and frameworks of both reshoring and the relationship between reshoring and environmental sustainability. The findings are linked to management theories such as Transaction Cost Economics and the Resource Based View to contribute in a significant way to the theory. Models and frameworks identifying drivers and barriers for backshoring, which also help assessing environmental sustainability within a decision-making process have been developed and may be of use to practitioners.

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### **List of abbreviations**

WCED -World Commission of Environment and Development

FPSO- a floating production storage and offloading

CO<sub>2</sub>- carbon dioxide

IPCC- The Intergovernmental Panel on Climate Change

GWP- Global Warming Potentials

SDGs- Sustainable Development Goals

UN- The United Nations

DDP delivery—delivered duty paid

NOV- National Oilwell Varco

GHG- greenhouse gases

RQ- research question

FCCC -Framework Convention on Climate Change

OECD – The organization for economic cooperation and development

G20- Group of 20

UN Climate Change Convention- United Nations Climate Change Convention

GDP- Gross Domestic Product

CEO- Chief executive officer

US- The United States

EU- European Union

WMO -World Meteorological Organization

UNEP-The United Nations Environment Program

EMS- Environmental management system

ISO- International Organization of Standardization

TQM- Total Quality Management

TRM-Total Responsibility Management

TCT- Transaction Cost Theory

RBT- Resource Based Theory

OBB- Organizational buying behavior

CSR- Corporate Social Responsibility

ECA working group- Economics of Climate Adaptation Working Group

LCA-Life Cycle Assessment

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# 1. Introduction

The chapter presents a concern of global climate change, and the challenge society stands in front of. There is still an uncertainty about the direction climate change would go. There is a growing consensus among corporate leaders that taking actions to protect the climate is a responsible business decision. (Andrew J. Hoffman., 2007) Globalization as a strategical trend for the past decades resulted in international supply chains. Recently, we are witnessing a major change. (N. Kandil, et al, 2020)

Companies have revised their location decisions implementing “relocation of the second degree”. More specifically they have relocated manufacturing activities either in their home country (back-shoring), in their home region (near-shoring) or in a further away location (further offshoring). (M. Mlody, L. Fratocchi. 2022).

However, the purpose of the case study is to explore and investigate current CO2 emissions and the perspectives for reducing them for the alternative manufacturing venues for crane linked to the project called “Jotun A”. The question is whether there are opportunities to implement back shoring instead of offshoring to reduce CO2 emissions? What are the drivers and obstacles for both sourcing and location decisions in the Supply Chain Management? Research questions and research objectives were created to approach closer to the main problem of case study.

## 1.1 Background of the study-about sustainability and green logistics

*“No challenge poses a greater threat to future generations than climate change.”*

Barack Obama, 21. January 2015

Darwin’s insight was that anything that is against nature will not last for long. (Wolf-Rüdiger Bretzke, Karim Barkawi, 2013)

The fact is that our economy needs to be ecologically restructured. The focus from the source of all cycles of regenerability of scarce resources has already changed to the absorptive capacity of the earth. (Wolf-Rüdiger Bretzke, Karim Barkawi, 2013)

Climate change creates a systematic risk across the entire economy. It has a huge influence on energy prices, national income, health, and agriculture as well as it creates risks at the sector, industry, and company levels.

Climate change affect the competitive environment and certain companies, sectors, industries are at higher risk than others. (Wolf-Rüdiger Bretzke, Karim Barkawi, 2013)

According to E. Barbier since the 1950s environmental challenges evolved and the economic view on natural resource scarcity have evolved. (Barbier, E.B, 2021)

Modern global climate change is dominated by human influences, and it exceeds the bounds of natural variability.

Perturbations are to the large degree the result of emissions associated with energy use.

All changes in atmospheric composition considering local and regional scales, urbanization and land are also crucial.

Although there has been a significant progress when it comes to monitoring and understanding climate change there are still many impediments to precisely planning for, adapting to and mitigating to climate change.

There is still considerable uncertainty about the rates of changes however there will be seen unusual and tangible events such as changes in extremes of temperatures, decreases in seasonal and perennial snow and ice extent and sea level rise.

Unknown with climate and its disruptive impact is an increasing concern for society. To face the challenge companies, acknowledge carbon emissions as a causal factor. Moreover, they are pursuing “carbon footprint “as a contribution to global climate change. (Thomas Day, et al, 2022)

Companies face call from a great number of stakeholders to take responsibility for the impact of their activities. Most large companies have implemented public climate strategies and targets including pledges to reduce and even eliminate their contribution to global warming. (Jan Anton van Zanten, Rob van Tulder, 2021)

Moreover, challenges of global warming, the loss of biodiversity, scarcity of natural resources require sustainable solutions from today’s companies. It is forcing the companies to reconsider the approach in conducting their business operations -production processes, logistics and business models. New economic models of production and consumption must consider its environmental and social impact. Companies face a pressing challenge to deliver more products whilst using less resources and emitting less pollution and waste. Pursuing more environmentally friendly products and business

operations contribute to company's improved operational efficiency and competitive advantage.

### ***Sustainability***

It is steadily more important requirement for human activity, making sustainable development a key objective in human development. Making development sustainable is challenging task involving factors as technology and engineering, economics, environmental stewardship, health and welfare of people, social cases and government strategies, procedures, and policies.

### ***Sustainable development***

Has been defined by the World Commission of Environment and Development (WCED) in 1987 as:

*“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”*

According to Gaziulusoy (et al., 2013) sustainable development is not an “end state” that can be attained but should be perceived as a “moving target” that is changing.

The concept of sustainable development emphasizes the influence human well-being and environmental sustainability has on each other while being integrated across space and time. (WCED, 1987) (Meuer et al., 2019)

### **Sustainable practices to help companies to contribute to sustainable development (CORPORATE SUSTAINABILITY)**



Millie

Figure 1: Illustrates corporate social responsibility.

Corporate sustainability is an ambiguous concept interpreted in various ways by scholars.

Meuer interprets it as: “*a bundle of activities fully integrated into a firm's overall strategy that contributes effectively to the welfare of current and future generations through protecting and enhancing the resilience of the biosphere, social equity and cohesion, and economic prosperity*” (Landrum, 2017)

It is commonly understood as the ways how company engage in and contribute to sustainable development. (Hajer, M., Nilsson et al, 2015)

Companies play a decisive role in achieving the Sustainable Development Goals (SDGs). The question is: how companies can ensure that their strategies effectively contribute to sustainable development?

*According to Peter Drucker: “What is most important is that management realize that it must consider the impact of every business policy and business action among society. It has to consider whether the action is likely to promote public good, to advance the basic beliefs of our society, to contribute to its stability, strength, and harmony.”* (Peter Drucker, 1954)

A nexus approach induces companies to assess and manage their positive and negative interactions with the SDGs which may arise in an integrated manner.

This approach aims to advance multiple SDGs simultaneously and is not treating SDGs as isolated silos. As a result, this approach is avoiding trade-offs.

Companies have capabilities that can advance sustainability objectives (Frynas, J. G., 2005)

Besides companies often negatively impact sustainable development. (Kourula A , et al 2017)

The United Nations (UN) has recognized critical role that companies play in the SDGs. According to the 2030 Agenda of Sustainable Development intergovernmental agreement state that: “*We acknowledge the diversity of the private sector, ranging from micro-enterprises to cooperatives to multinationals. We call upon all businesses to apply their creativity and innovation to solving sustainable development challenges.*” (UN, 2015 p. 29)

Corporate sustainability is a mainstream ambition and over 15000 companies around the world signed up to the United Nations Global Compact that have made a commitment to implement universal sustainability principles. (United Nations Global Compact, 2020).

Corporate sustainability makes business sense and some authors in the literature were pointing out some advantages for the company: support financial performance of the



company, enhance legitimacy, reduce reputational risk, improve relationship with stakeholders and help identify future possibilities.

Corporate sustainability contributes to sustainable development since companies strive for reaching SDGs. Some of them integrated goals into the core strategy. (J. Sanchez-Planelles, et al, 2022)

There is a huge pressure on the companies to reduce their environmental impact but managerial tools and frameworks to bring sustainability to practice are in their infancy. (Nordin Norani, 2014)

### ***Sustainable manufacturing***

Aims to minimize the impact of manufacturing operations on the environment while optimizing the production efficiency of firms. Today products are not judged by the price, but the sustainable initiatives implemented by the companies. Traditionally efforts to reduce environmental impacts of manufacturing operations have been seen as an obstacle to the probability and efficiency. However, efforts to protect the environment may also result in reduced operating costs and improved employee workplace satisfaction. (Muhammad Shabir Shaharudin, et al 2021)

### ***Green Supply chain management, low carbon supply chain management and sustainable supply chain management***

Have acknowledged the importance of environmental friendliness criteria. Operations cluster has been behind when recognizing the environmental friendliness criteria. (Biermann F., Norichika, 2017)

There is not a single area of business that was not touched by the climate change, product stewardship, trying to do more with less and improving energy consumption. In today's omnichannel environment, sustainability has become a key initiative that is important in a firm's success irrespective of whether the firm sells its products or services on the internet, through physical brick- and-mortar stores or a combination of those two.

The paradigm of the "***Triple Bottom Line***" is actually a popular way of describing UNs definition of sustainability – by dividing it into environmental, economic, and social sustainability.

"Brundtland Report" identifies those three mentioned pillars as: "planet", "people", "prosperity". (Brundtland et al., 1987)

Environmental sustainability means the ability to avoid depletion of non-renewable resources and reducing pollution caused by human activities.

Social sustainability means ability to spread social well-being.

Lastly economic sustainability is associated with efficient distribution of resources at a global level.

Productive activities have an impact on all three pillars. (Sutherland et al., 2016)

Therefore, decisions about production place have a huge importance on the company's sustainability.

Many researchers investigating the offshoring and global sourcing focused on sustainability issues and the delocalization of manufacturing activities. (Jia and Jiang, 2018)

The UN 17 sustainable development goals mark a historic shift towards one sustainable development agenda after a long history of trying to integrate economic and social development with environmental sustainability. (J. Sanchez-Planelles, et al, 2022).

One of the goals is pertaining to responsible production and consumption. It is about promoting resource and energy efficiency, sustainable infrastructure and providing access to better quality of life. The aim of sustainable consumption and production is to “do more and better with less” increasing net welfare gains from economic activities by reducing resource use, degradation, pollution along lifecycle while increasing quality of life. It requires cooperation among actors in the supply chain from producer to final customer. (UN Responsible Production and Consumption)

### ***Sustainable logistics***

Mobility and logistics activities for centuries have been perceived as contributing to economic development and well-being. Lately, they have been a key determinant of business performance. (Nordin Norani et al, 2014)

The evolution toward globalism and the opportunities created by technological innovation have increased the significant role of mobility and logistics worldwide.

Logistics and mostly freight transport have received much attention in sustainability since they affect all individuals.

Stakeholder involved in logistics have introduced some concepts addressing the importance of the term sustainability.

These similar concepts differ in their approach.

### ***Green Logistics***

Focuses on ways to reduce the environmental impact of logistics. (Muhammad Shabir Shaharudin et al, 2021)

## Sustainable Logistics

Aims to improve economical, ecological, and societal interests at the same time. It focuses on triple bottom line and its three P's (goals): people, planet, and profit. (Biermann F, et al 2017)

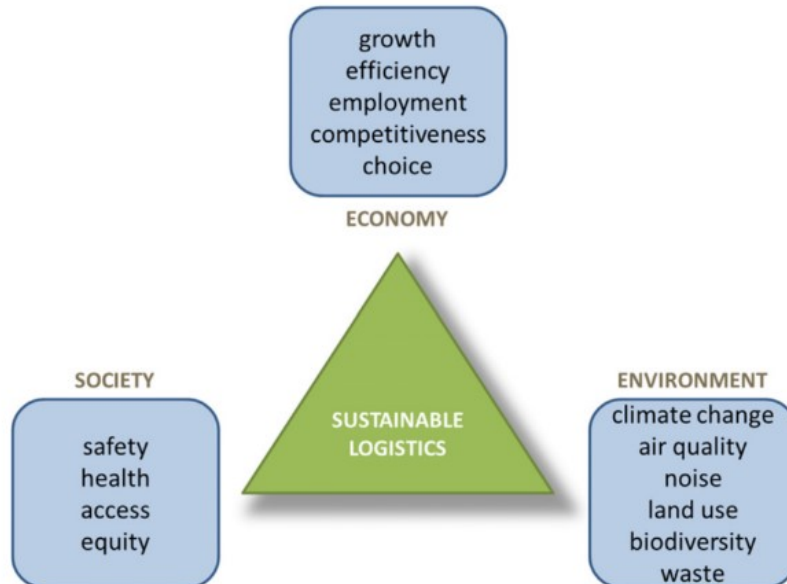


Figure 2 : Illustrates the framework for sustainable logistics (source: based on [www.greenlogistics.org](http://www.greenlogistics.org) ; McKinnon, 2010)

It is stated that investments in sustainable logistics should have a positive return as shown below.

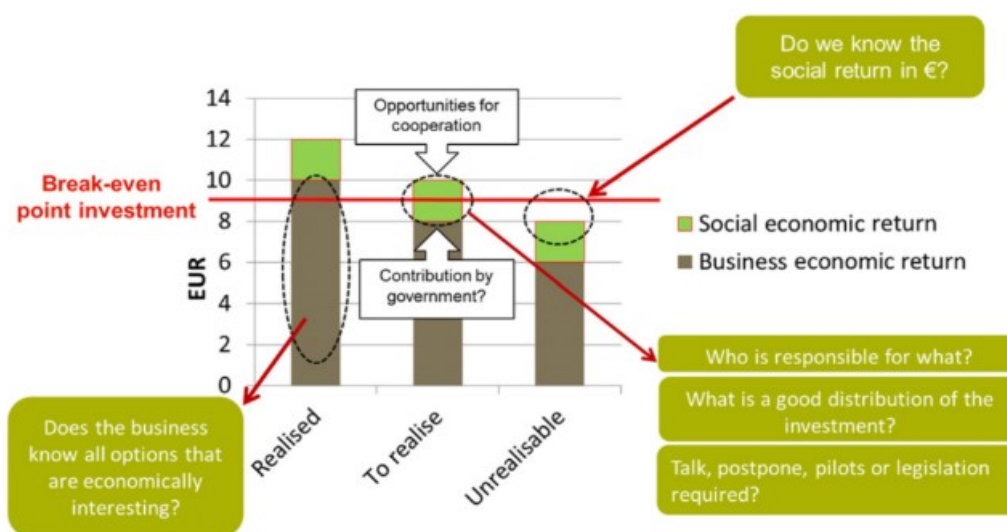


Figure 3: Illustrates selecting sustainable logistics measures (Cathy Macharis, et al, 2014)

There are several solutions connected to three types of projects showing opportunities to move closer to more sustainable organization and execution of logistics activities.

Logistics is important for reducing greenhouse gas emissions and reducing the dependency of economy on non- renewable energy sources. (McKinnon, 2010)

The contribution of logistics sector to sustainability has so far been measured by reduced logistics costs. (Cathy Macharis, et al 2014)

However, its potential is larger as it can make larger steps in reducing CO<sub>2</sub> emissions with cost neutral measures or small cost increase. (Cathy Macharis et al, 2014)

IPCC calculated that limiting the increase in global mean temperature to 2 degrees Celsius requires lowering of global greenhouse gas emissions by 40-70% by 2050 (compared with 2010) and to near-zero by the end of this century. (IPCC, 2014).

Industrialized countries will need to reduce their greenhouse gas emissions by 80% or more in 2050 compared to 1990 to give the chance to developing economies for growth.

European Commission has set a goal for the transport sector to reduce greenhouse gas emissions by 60% from 1990 to 20150. (European Commission, 2011 a)

The scarcity of energy in the period up to 2050 encourages to reduction the consumption of fossil fuels.

The challenge of shortage in oil and oil- derived fuels could be solved by increasing the use of natural gas and fuels derived from natural gas.

Rapid development in shale gas and oil production from tar sands could provide time to energy scarcity.

This option is not good from the climate change perspective since it postpones transition to a low carbon economy as well as gives possibilities of increase in emissions combined with production of oil and gas using unconventional resources.

Europe's logistic sector is experiencing a tremendous difficulty in halving fossil fuel use and greenhouse gas emissions since it is striving to cater increasing demand for goods transportation in a cost – effective way.

## **1.2 CASE DESCRIPTION**

NOV is a leading provider of technology and equipment within the energy sector and aims to participate in the world's transition to a low – carbon future.

NOV is a global company with the number of employees around: 1260 people.

The figure below shows where NOV is located:



Figure 4: Illustrates the locations of NOV globally and in Norway (source: NOV presentation)

The company is multinational and provides oilfield equipment, expertise and technologies to the oil and gas industry.

Specifically, the company is involved in sectors as presented below:

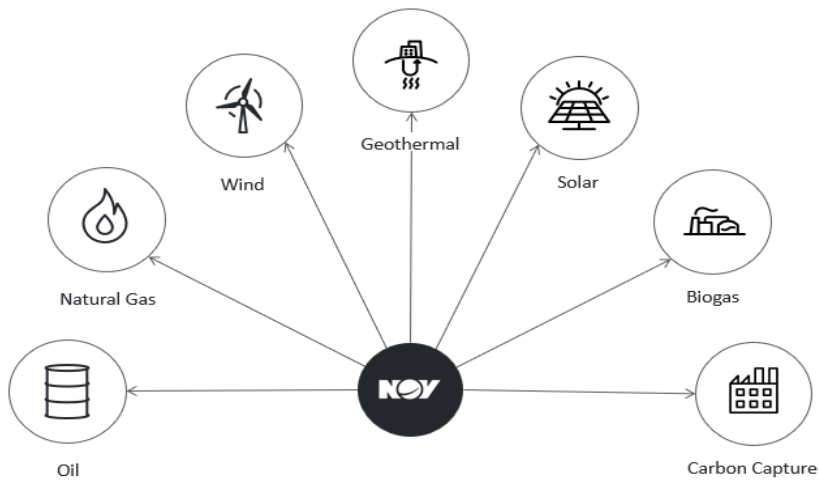


Figure 5 : Illustrates which sectors NOV is operating in (source: NOV presentation)

Considering production site is in South Korea. However, repair works take place in Norway- in Kristiansand.

It has customers such as some few mentioned below:

**Oil companies:**

- Equinor



- ConocoPhillips



- Aker BP



- Neptun



- Vår Energi



- OKEA



- Shell



**Boring companies:**

- Seadrill



- Transocean



- Odfjell



- Saipem



- COSL



- Maersk



- Noble



**Other suppliers:**

- Bosch Rexroth



- Siemens



- Siebenhaar



- Ropeblock





- Parker



- Hydac



- Teufelberger



The structure of NOV is shared by parts: Aftermarket, Completion & Production, Wellbore technologies



Figure 6: Illustrates the structure of the company (source: NOV presentation)

Company's history starts from Stålprodukter and can be summarized by the figure which NOV has prepared:

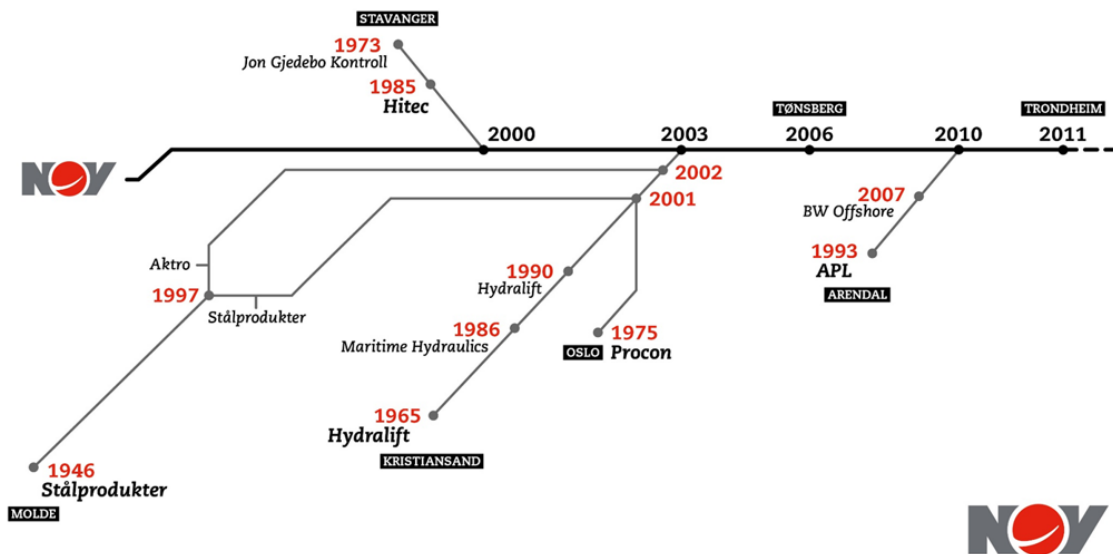


Figure 7: Illustrates the history of NOV (source: NOV presentation)

Moving to transition to clean, carbon neutral energy is leading to economic opportunity that can improve the economic competitiveness of renewable energy. (Cathy Macharis et al, 2014)

According to The International Energy Agency approximately 71 trillion dollars or 3.4 trillion dollar per year must be spent for global CO<sub>2</sub> emissions by 2040. (Ruijgrok, 2012) NOV claims to be a low carbon actor and takes actions. Processing business enables CO<sub>2</sub> from hydrocarbon separation, dehydration and liquefaction vital parts of the carbon capture chain. (NOV Inc., 2021)

NOV has developed a few solutions to lower the carbon and environmental footprint of the oil and gas industry:

- ✓ Closed-loop solids control and thermal desorption systems.
- ✓ Dual-containment flowline technologies
- ✓ Solar pumping systems
- ✓ Hydrocarbon leak detection systems

NOV has lately introduced technological innovations:

- NOV's Power Blade™ Kinetic Energy Recovery System- technology that utilizes both flywheel energy and lithium-ion battery energy storage to reduce fuel consumption and emissions associated with drilling and hoisting.

The Power Blade™ system captures and regenerates electrical energy that would have previously dissipated as heat when a draw works, crane, or winch slows and stops. The Power Blade™ system then returns this energy when needed.

- Ideal eFrac™ fleet, delivering advanced stimulation technology to reduce emissions and decrease ownership cost. The patent-pending Ideal eFrac™ system has a task to enhance safety while minimizing hazardous situations. The Ideal eFrac™ system is less disruptive due to its reduced noise and smaller footprint.

### 1.2.1 Description of case study – new cranes for Jotun A

(NOV Inc., 2021)

The project is considering Jotun field which is in the North Sea 200 km west of Stavanger. The field is equipped with two installations: a production vessel (Jotun A) and a wellhead platform (Jotun B).

The Jotun A provides spare production capacity and is connected to Balder and Ringhorne via a pipeline. This enables parts of the Balder and Ringhorne volumes to produce via Jotun floating production storage and offloading (FPSO).

There is planning extended production in the Balder and Ringhorne area until 2045 and upgrading of Jotun FPSO which would be located to Balder field.

Owner of the Jotun FPSO is Vår Energi AS.

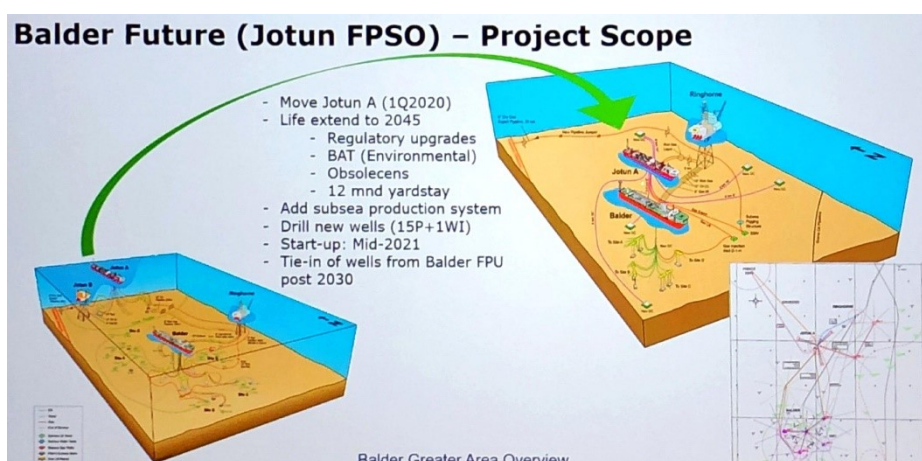


Figure 8: Illustrates Jotun FPSO and the project scope.

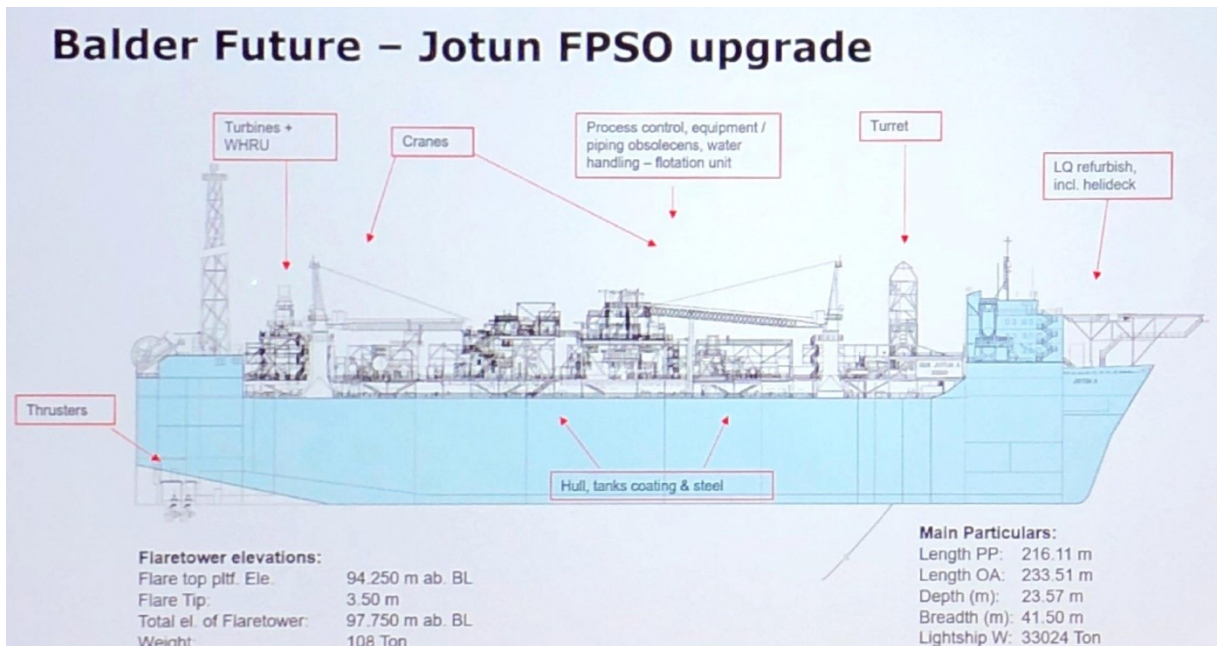


Figure 9: Illustrates Jotun FPSO upgrade.

Description- cranes:

- Two electric offshore cranes
- Two pedestal adators for welding to existing pedestals
- Transport DDP delivery of cranes in modules and pedestal adapters





Figure 10: Fully electric offshore cranes (Source: NOV)

**Production of the crane**

Main <u>assy</u> and testing:	NOV Korea
Steel structure:	NOV Korea
Winches:	NOV Korea
Machinery House:	NOV Korea
Cabin:	NOV Stavanger (Miller cost)
Electrical Cabinets:	NOV Stavanger
Pedestal Adapter:	NOV Korea (or another)

Figure 11: Illustrates production place of the parts of the crane (resource: presentation : Handover to project- New cranes for Jotun A)

As we see from the figure above the production place of the crane is decided to be in Korea. The same production place is when it comes to steel, winches, machinery house and pedestal adapter. However, cabin and electrical cabinets are made by NOV Stavanger – in Norway.

Case study considers two electrical cranes which are produced in South Korea (as it is presented in the figure 7) and would be shipped by boat to Norway.

As figure 7 describes some parts of the crane as cabin are produced in NOV Stavanger in Norway.

Figure 8 presents the responsibility for the project. When it comes to project manager it is – Tommy J who I believe has an outstanding insight of the project and that is why he is chosen as one of the people who is chosen to interview.

### **1.3 Scope of the study**

The study seeks to find out potential drivers of manufacturing in Korea comparing to Europe when it comes to the issue of reducing CO<sub>2</sub> emissions. Transport emissions are significant when it comes to CO<sub>2</sub> emissions and by focusing on sustainable logistics the study is exploring what is optimal sourcing solution with respect to climate protection.

The commitment of Europe and the Scandinavian region toward climate change contributes to

Case study presents cranes which are sourced from South Korea. However, the study identifies if there are better perspectives to source from Europe instead to reduce CO<sub>2</sub> emissions?

Moreover, the seriousness of the European Commission and European region with its policy and actions makes the analysis of this region representative.

### **1.4 Significance of the study**

The analysis of motivations of backshoring is of great relevance because it can throw light on whether backshoring is the failure of the offshoring initiative or the evolution of firm's competitive strategy.

The study is providing researchers and academicians useful information and knowledge on backshoring and the perspective of its trend.

Lastly the findings of the study serve as a steppingstone for research conducted on the related topics through recommendations made for further research.

The findings of this study could serve as a basis for the development of sustainable production and logistics by promoting reshoring.

## **1.5 Research questions**

There are a few research questions that have been developed in this case study.

The main research question is:

***“Reducing the environmental footprint by back shoring manufacturing? To what extent could European production outperform Asian production with respect to climatic impact? The case of offshore crane manufacturing”***

The following research questions could be formulated under the research problem:

### **RQ1 : Why should manufacturing companies reduce their climatic impact?**

**RQ1.1** Which challenges do the current emissions of greenhouse gases (GHGs) represent?

**RQ1.2** To what extent are the emissions of GHGs related to the manufacturing industries?

**RQ1.3** Which motivations could a manufacturing company have for reducing their climatic impact?

**RQ1.4** What are incentives for back shoring?

**RQ1.5** What are challenges/obstacles for back shoring?

This research question aims to find out the reasons why it is important for the manufacturing companies to reduce their emissions of greenhouse gases. The study seeks to determine how manufacturing companies can influence the challenge of climate change and what actions can be undertaken.

### **RQ2: Which strategic and operational measures could manufacturing companies use to reduce their climatic impact?**

**RQ2.1** How could the choice of supplier is affecting the climatic impact?

**RQ2.3** Which new solutions could contribute to decarbonization?

**RQ2.4** To what extent could electrification makes a difference in the reduction of emissions?

This research question seeks to find out the factors that may cause reduction of climatic impact. The study seeks to determine the critical factors which affect the reduction of CO2 emissions. Hence there are investigated various drivers and bottlenecks which may facilitate development or hinder the reduction of climatic impact.

**RQ3: What is the current climatic footprint of NOV's crane production in South Korea?**

**RQ3.1** What is the use of the electric energy in manufacturing in Korea.

**RQ3.2** Which indirect GHG emissions could be related to electricity production in South Korea

**RQ3.3** Which GHG emissions could be related to the transportation of the crane from Korea to Europe?

This research question aims to define how electric energy in South Korea contribute to lower climatic footprints. Additionally, by finding out emissions related to transportation of the crane from South Korea to Europe we try to bring to light the challenge of these related emissions.

**RQ4: How would the climatic footprint of NOV's crane production change if production was to be moved back to Europe?**

**RQ4.1** Which locations could be used as examples in Europe?

**RQ4.2** Which indirect GHG emissions could be related to electricity production in these European countries?

**RQ4.3** Could the GHG emissions from manufacturing and transportation be reduced by moving production to these countries?

This question seeks to determine how moving production of the crane back to Europe could influence the issue of climatic footprints. Additionally, the study seeks to explore two alternatives -producing in South Korea and on the other hand moving it back to Europe and to answer the question how emissions change according to those alternative solutions.

## **1.6 Structure of the thesis**

The structure is divided into the following chapters:

- **Chapter 1** presenting the case study and the research problems and objectives.
- **Chapter 2** presents chosen research methodology.
- **Chapter 3** describes the literature review.



- **Chapter 4** showing the analysis and the experts' findings.
- **Chapter 5** illustrates the discussion between findings in the literature and expert interviews.
- **Chapter 6** aims to find a conclusion and give some suggestion for further research.

## **2. Research methodology**

Research refers to searching for knowledge. (C.R. Kothari., 2004).

According to Redman and Mory research is defined as an effort to obtain new knowledge. It often occurs because of our inquisitiveness and searching out the information to the unknown. (Saunders et al. ,2016)

Clifford Woody defined research as defining and redefining a problem, formulating hypothesis, working with data, and making and testing conclusions to verify if they fit to the hypothesis. (Saunders et al. ,2016)

This chapter presents research approach chosen while working on the research process as well as describe chosen tools.

The objective of research is to answer questions through scientific procedures.

### **Significance of research**

According to Hudson Maxim research is about inquiry that leads to invention. Research is often used to solve operational problems and has gained its importance for: government and business. It is common that research enables the decision making by the policy makers. Moreover, it contributes to solving some operational and planning problems of the companies and industry. Finally, it helps in solving social problems.

### **Research methods and methodology**

Research methods/techniques is understood as methods/techniques used for conduction of research.

On the other hand, methodology is a scientific way to systematically solve research problems. (C.R. Kothari., 2004).

Research methodology concerning a research problem is finding out:

- Why a research study has been taken?
- How the research problem has been defined?
- Why the hypothesis has been formulated?
- How data has been collected?
- What methods have been used?

- Why some techniques of analyzing data have been chosen?

Social science research can be categorized as: (“Research Methodology”

, D K Bhattacharyya)

- **Fundamental (basic) research** to find out certain principles.
- **Applied research** as application of scientific methods to contradict, change or modify any existing theories.
- **Descriptive research** as a fact-finding approach generalizing cross sectional study of the situation.
- **Historical research** is based on past events to shape a present state.
- **Formulative/explanatory research** is finding out any problems using suitable hypothesis.
- **Experimental research** is either with the help of hypothesis or quantifying the findings by using mathematical and statistical tools.
- **Ex-Post Facto Research** is empirical investigation of the present situation.
- **Case study approach** is often undertaken at the micro level and is an intensive approach.

People think about the future preparing to desirable or undesirable events. This is known as future oriented thinking. Future and expectations have a decisive role on our present behavior. (Aspinwall, 2005).

Miller, Polli and Rossel (2013) are defining the process of finding out about the future as “anticipation” of the actions that is allowing to consider future scenarios.

Voros (2017) defines anticipation as a methodological approach for predicting the future. Future oriented thinking is closer related to decision making process.

According to Niiniluoto (2001) thinking about the prospects of the future is common for scientific disciplines and is necessary for testing any scientific theory.

Exploration of future is quite a new approach of science (Delaney, 2002).

To create futures research design, it is necessary to identify logical steps linking epistemological and ontological assumptions with research methods.

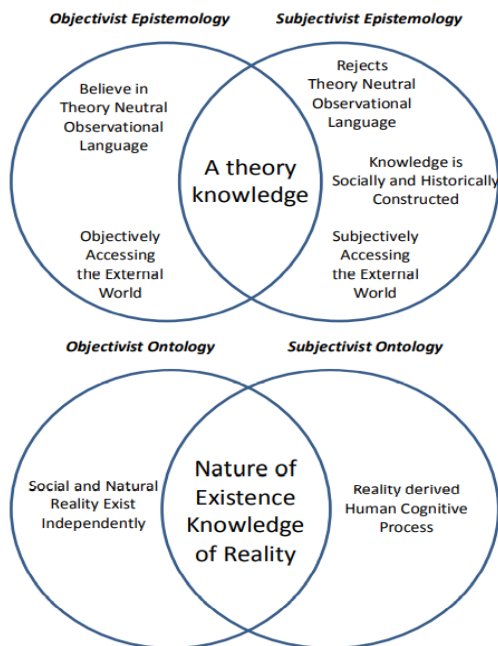


Figure12: Illustrates overview of Epistemology and Ontology (source: [Microsoft Word - Wong et al pdf \(psu.edu\)](#))

One of the frameworks used by researchers is based on the concept of research onion suggested by Saunders et al. (2016).

According to Muranganwa(2016) [methodology.pdf](#) research onion concept creates a base for developing a good research design.

Raithatha (2017) claims that research onion model allows to creating main academic research model.

This framework integrates already developed theoretical knowledge with future studies and is presented by seven layers.

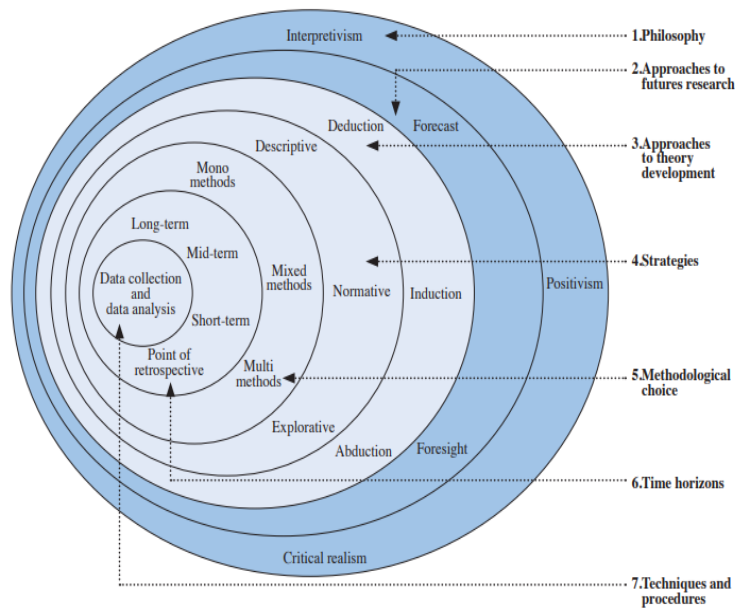


Figure 13: Illustrates research onion for future studies; source: Saunders et al. (2016)

The methodology of this study is relevant to the Research Onion as presented in figure 3 consisting of the following layers: starting with “philosophy” and then progressing through: “approaches”, “strategies”, “methodological choice”, “time horizon” and “techniques and procedures”.

To summarize it: research onion consists of parts: (A. Melnikovas , 2018)

1. **Research philosophy**- forms research by precising nature of reality, nature of knowledge and values of the research
2. **Approach to theory development**- often include:
  - Deduction
  - Induction
  - Abduction
3. **Methodological choice**- as associated with the choice of methods: quantitative or qualitative or the mixture of both.
4. **Strategy**-is based on collecting the data and analyzing.
5. **Time horizons**-distinguishes between short term horizon at a specific time and long term -repeatedly over a long period of time.
6. **Techniques and procedures**- contains data collection and analysis.

## 2. 1 Research philosophy

According to Saunders et al. (2016) a classical research methodology is based on chosen philosophical theory and following it strategies and techniques of the research. Research philosophy is perceived as a set of beliefs and assumptions about knowledge.

According to Creswell and Poth (2016) there are following philosophical assumptions:

- Ontological which defines the nature of beings.
- Epistemological highlights knowledge contributing to the theory.
- Axiological pointing to the values in the research
- Methodology means research procedures and practices to obtain knowledge.
- Rhetoric using research language.

Historically there were two classical research philosophy: positivism and interpretivism. Lately it appeared two other positions: pragmatist and critical realist. (C.R. Kothari, 2004) However, choosing philosophy in future studies can be difficult since there are missing empirical evidence of the future.

First step is to determine the operational field of the research and data sources.

For the research with quantitative data *Positivism* can be chosen as a philosophy. It is common for the fields as demography or economic development for the calculating the future and exact predictions.

On the other hand, for the research with the qualitative data main philosophy can be either *Interpretivism* or *Critical realism*.

Positivist philosophy claims that entities exist independently of human beings and conversely interpretivists claim dependence of the world on humans. Interpretive position is appropriate to research focused on the insights of the future.

Critical realist proposed by Bhaskar position is basically used for the future scenarios.

In the 1970's a new challenging philosophy occurred as a manifest to positivism and interpretivism proposed by Bhaskar-theory of critical realism.

According to Bhaskar (2008) present, past and future are not dependent on knowledge or experience and critical realism constitutes as a bridge between explanation and understanding.

Saunders et al. (2016) suggests two other philosophical positions:

1. *Pragmatism* assuming possibility of using both positivist and interpretivist positions for research question.
2. *Critical realism* if the world consists of entities, and we can observe them by perceiving them and their actions.

Kosow and Gaßner (2008) claim that the future can be seen from different views:

- Future is predictable.
- Future is evolutive.
- Future is malleable.

Inayatullah (2013) offered quite similar categorization of future to:

- Predictive

- Interpretive
- Critical

Kosow, Gaßner as well as Inayatullah and their perception of the future connect positivism, interpretivism and critical realism together.

To summarize it up, research philosophy is a foundation that contributes to the decision of choosing methods, strategy, data collection techniques and interpreting the results of the research. (C.R. Kothari, 2004)

As the case study combines ontological and epistemological assumptions searching for the future insights the research philosophy appropriate to it is interpretivism.

### **2.2.1 The philosophical stance of this study**

Interpretivism is associated with qualitative research. (Pulla&Carter, 2018).

It considers researcher to already have basic knowledge and preunderstanding of the research problem. These researchers are often attaching the research with pre-understanding and plan. However, they aim to gain new information and approach to research through chosen data collection techniques. (Hudson and Ozanne, 1988).

Interpretivism encourages researcher to explore the meaning in human behavior, interactions, and society. (Pulla&Carter, 2018)

Using the interpretive view, the interest of this study is the understanding human behavior in sourcing from home country contrary to abroad.

The fact is that using this technique in the social sciences like this can be challenging as it is difficult to empirically assess and explain the complexity of human behavior and connections between individuals and their social settings successfully. (Pulla&Carter, 2018)

The research philosophy explains how the researcher conduct the study and is helping researcher in the selection of the proper research approach.

## **2.2 Research approach**

**There are two basic approaches:** (C.R. Kothari, 2004)

- Quantitative approach is often formal and rigorous.
- Qualitative approach is a subjective assessment of attitudes, opinions, and behaviors.

Quantitative approach can be classified further to:

- Inferential aims to form a data base and inferring characteristics of population (usually survey research)
- Experimental consist of observation how some variables affect the other variables.
- Simulation approach is about creating an artificial environment and the observation of the dynamic behaviors within controlled conditions.

**Approaches to futures research** is a second step. Positive philosophical stance is often followed by forecast approach. Forecasting is aimed at finding out the exact future events. Another approach is fore signing which is based on qualitative techniques and is aimed at analyzing multiply futures.

Choosing the right approach is dependent on chosen philosophy and research approach.

There are different theory development approaches:

- Deductive approach
- Inductive approach
- Abductive approach

Deductive approach may relate to forecast as it leads to conclusions and the theory is verified by data.

Inductive and abductive approach are reverse to deductive approach as they start with data collection and end with theory.

According to Patokorpi and Ahvenainen (2009) deductive and inductive approach in futures studies relies on past probabilities whereas abductive approach is based on drawing conclusions from “low knowledge”.

This study is inductive since it starts with the research questions and objectives and lead to the result of research study.

## **2.3 Research design**

Research design is the step following defining a research problem. It is giving the answer to what, where, when, how much etc. concerning the research study.

A research design is set of conditions for the purpose of data analysis combining relevance to the research purpose with economy.

The design consists of:

- Writing a hypothesis
- Operational implications
- Final analysis of data

Considering design decisions, the research design may be split to parts:

- *The sampling design* deals with selecting the items of the research's interest.
- *The observational design* relating to the conditions which are relevant.
- *The statistical design* focus on the number of items of observation as well as how the data would be analyzed.
- *The operational design* which concerns techniques by which procedures can be performed.

Research design must contain (C.R. Kothari, 2004):

Statement of the research problem

- ✓ Procedures and techniques chosen in research.
- ✓ The population to be studied.
- ✓ Methods for analyzing and processing the data.

Research design is critical for the reliability of the results. Thus, the focus on planning methods and techniques with the objective of the research design is very important.

The risk of missing a proper research design leads to misleading results.

There are different types of research:

- ✓ Exploratory aims to get new insight.
- ✓ Descriptive presenting the present situation.
- ✓ Explanatory is finding out why something has happened.
- ✓ Improving consider present situation and changing it.

This study is classified as exploratory since it is analyzing the situation of CO<sub>2</sub> emissions and the future alternatives to reduce them. The study is future oriented.

## **2.4 Data collection approach**

This is very important part of research starting after defining a research problem and research design.

While deciding about method of data collection researcher need to decide what types of data would be implemented: primary or secondary or both.

Primary data are those which are collected for the first time and is original in its character.

Secondary data on the contrary are those which have been already collected by someone and had been processed statistically.

The methods of collecting data differ from primary to secondary data.

### ***Collection of primary data***

While doing experiments in experimental research we collect primary data.



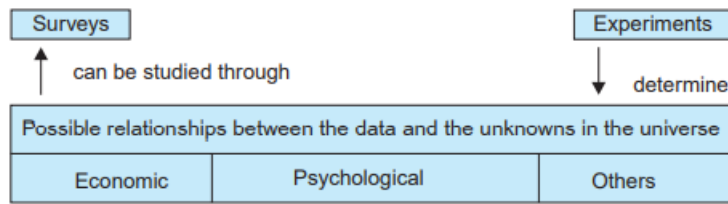


Figure 14: Illustrates the difference between experiment and survey source: [Research Methodology : Methods and Techniques \(aambc.edu.et\)](#)

**Observation method** needs to serve the objective of the research and be the subject to reliability and validity.

Both primary and secondary data were employed in this study.

#### 2.4.1 Literature survey

The literature survey of this study has been conducted secondary data. Procedure of gathering data from different books, journals, articles had been done by using search engines which are recommended for the scientific and academic research as google scholar or sci-hub.

Additionally, most of the academic articles had been gathered from sites as research gate, sciencedirect.com and springer.com.

There had been also used annual reports as a significant source of information.

#### 2.4.2 Semi- structured research interviews

Expert interviews were conducted to access qualitative data. A semi-structured interview was used in this study.

Interviews conducted in the study required confirmation from the Norwegian Center for Research data regarding data and personal protection of those who were chosen to participate.

Selection of interview guide with open ended questions lead us to discussion about relevant issues.

The aim of the study was to conduct face to face interview since we believe they have advantage comparing virtual interviews.

The key points of conducted interviews were to get the results about:

- Job description, expertise, and role of the expert

- Perspective on reduction of CO2 emissions and the issue of backshoring

Each interview was recorded and transcribed, and we planned the duration around: 30-45 minutes. Afterwards the transcribed interviews were sent to the interviewees for control and correction.

The relevance and validity of the interviews were checked and revised by using built-in reviews and gathering feedbacks about the interview process.

## **2.5 Analytical approach**

Data analysis is about: examining, categorizing, tabulating, testing and making conclusions.

Yin (2009) points out that it is one of the most challenging parts of the research since there are not any instructions for what the right procedures for are dealing with.

Dey (2003) presents a distinction between quantitative and qualitative data. He suggests using statistics and mathematics for quantitative data whereas conceptualization for qualitative data.

However, there is prerequisite that the data are evaluated and comprehended.

Considering this study there had been used mainly qualitative data obtained through interviews and document reviews as well as the quantitative analysis conducted by NOV.

Analyzing qualitative data can be done by using different techniques. (Yin, 2009)

As far as the study is concerned conducted interviews provided different replies and different meanings of the data which highlighted relevant points and information.

Various available data and notes had been grouped into cases and coded in respect to study topics. Afterwards responses from the interviews were summarized and the table for each study topics was prepared.

The analysis had been grouped into themes and presented.

In this study, responses from responders were carefully assembled, coded and presented.

The outputs were compared to determine patterns in the responses.

## **2.6 Chapter summary**

The methodology of the study is presented in this chapter. When it comes to this study there was used expert interviews and literature survey to determine the potential drivers for backshoring.

It is classified as exploratory research as the study explores the potential of backshoring as logistically sustainable solution.

Interpretivism is a philosophical basis for this study and is helping to make the methodological choices.

This study uses an inductive approach as it begins with research questions and findings provide the answers to them.

Furthermore, the choice of this research is a mixed methods approach, and the aim is to find out the potentials for backshoring and how they contribute to sustainable development through experts' interviews and secondary sources.

Additionally, there had been used multi method qualitative approach based on conducted interviews and document review.

### **3. Literature review**

Fink (2019) suggests that literature review is a systematic, explicit, and reproducible method for systemizing the work made by researchers or practitioners. (Andrew Booth, et al, 2022)

According to Webster and Watson (2002) a successful literature review reveals some areas where research is necessary and point out the advancement of already existing theories.

Literature review enables interacting with existing theory (Noyes et al., 2016).

However, literature review can also lead to generating new theories and interpretations. (Andrew Booth, et al, 2022)

This section highlights literature review contributing better comprehension of two major milestones of this study: offshoring and back shoring and their impact on CO2 emissions (sustainability impacts).

The main literature of this study focuses on topics such as: climate change, environmental benchmarking, competitive environmental advantage, sustainability and back shoring /offshoring, shareholder value maximizing and risk mitigation.

At the beginning the aim of the research was to introduce the reader to the background of the research problem and afterwards the focus was to the insights of it. (Campbell et al., 2014, Oliver et al. 2018)

### 3.1 Climate change

*“There is an infinite amount of hope in the universe ... but not for us.” Franz Kafka, c. 1920 [44]*

Global warming is a fact that is happening and is indisputably due to human impact resulting in unnatural amounts of greenhouse gases into the Earth’s atmosphere within last 200 years.

Global warming constitutes a threat for human’s life and survival. (John P. Tiefenbacher, 2020)

Climate change is one of the complications of global warming and the issue for humanity. (John P. Tiefenbacher, 2020)

FCCC (Framework Convention on Climate Change) defines climate change as:

*“a change of climate that is attributed directly or indirectly to human activity, that alters the composition of the global atmosphere and that is in addition to natural climate variability over comparable time periods.”*

To put it shortly -FCCC perceives climate change as atmospheric changes caused by human activity.

IPCC (Intergovernmental Panel on Climate Change) defines it broadly as:

“Any change in climate over time whether due to natural variability or as a result of human activity”

The main reason for climate change is different concentration of greenhouse gases in the atmosphere. (Water vapor, carbon dioxide, methane, ozone, perfluorocarbons).

Climate change affects everyone. The impact of it is melting polar ice shields, rising sea, extreme weather events as rainfalls or heat waves and droughts.

Climate change is a serious threat that has an influence on our lives especially in African countries.

Developed countries had this advantage that they managed to minimize the adverse effects of climate change due to:

- Natural advantage
- Easiness for adaptation techniques
- High technology
- Wealth status

Report by ND-GAIN indicates that it would take more than 100 years for the poorest countries to reach the adaptive capacity of OECD countries with higher income. Predictions made by climate change research organizations and scientific reports suggest increasing frequency and intensity of climate change in developing countries such as Asia and Africa.

Appropriate actions in the face of climate change are necessary elsewhere the future of developing countries would be unbearable. (Joseph Romm, 2022)

Climate change leads to increase in the temperature of the planet and the process already started in the beginning of the twentieth century with the industrial revolution. (John P. Tiefenbacher, 2020)

There are causes of climate change as: burning fossil fuels, cutting down forests and farming livestock affecting the climate and the earth's temperature.



Figure 15: Illustrates causes of climate change (source: [https://climate.ec.europa.eu/climate-change/consequences-climate-change\\_en](https://climate.ec.europa.eu/climate-change/consequences-climate-change_en))

Changes in the radiative balance of the Earth and increase caused by increase in greenhouse gases or in aerosols influence atmosphere and ocean temperature. Prediction of climate changes require accordingly the investigation of their concentrations. (Alexey Mikhaylov, 2020)

### **Drivers of climate change**

Drivers in this context are associated with economic growth and human well-being. They constitute a threat for the climate change and to put it shortly – changes in GHG emissions. While talking about climate drives there are those of: natural and anthropogenic origin.

Natural ones are changes in solar irradiance, volcanic eruptions, the El Niño–Southern Oscillation. (Nigel Arnell, 2015)

According to IPCC there are anthropogenic activities causing changes: consumption, international trade, population growth, economic growth, and some structural changes. (William D. Nordhaus, 2013)

Economic and population growth are perceived to be the most significant drivers for the increase in CO<sub>2</sub> emissions from fossil fuel combustion.

Considering population growth between 2000-2018 the contribution remained the same however economic growth has increased rapidly.

### **G20 and climate change**

Climate impacts have already influenced G20 countries which have different level of vulnerability.

Climate change is the issue of disruption of the development highlighting gender inequalities and social and economic injustices.

*“One of the greatest inequalities in the world is reflected in the causes and consequences of climate change which threatens the livelihoods of billions of people, especially women and girls.” Wolfgang Jamann, CEO and Secretary General of CARE International*

Important role plays CO<sub>2</sub> in the Earth’s energy balance. In the late 19<sup>th</sup> century Swedish scientist Svante Arrhenius suggested a link between CO<sub>2</sub> and temperature.

The excess of CO<sub>2</sub> emitted by fossil fuel burning and other human activities is a problem since those remain in the atmosphere for centuries. (Solomon et al., 2009).

Emissions from fossil fuels have increased drastically over the last two decades -rising 41% since 1990.

CO<sub>2</sub> emissions caused by land use are changing and are dominated by tropical deforestation.

According to La Quere et al. (2009) between years 2000-2008 land use changes released 5.1 plus minus 2.6 Gt of CO<sub>2</sub> each year while fossil fuel burning, and cement production released 28.2 plus minus 1.7 Gt of CO<sub>2</sub> yearly.

Up to 1950 many scientists believed that excessive CO<sub>2</sub> released by human activities would be absorbed by the world’s ocean.

In the late 1950 American oceanographer Roger Revelle and some collaborators suggested a hypothesis that world's ocean could not absorb all the excess CO<sub>2</sub> released from fossil fuels burning.

The so-called Keeling curve reveals that atmospheric CO<sub>2</sub> concentrations are at present twice as big as they were during the first decade of the record. This increase can be explained by the rise in CO<sub>2</sub> emissions due to increase in energy use and development. Canadell et al. 2007, Khatiwala et al, 2009 claim that the rate of CO<sub>2</sub> emissions removed from the atmosphere by ocean and land sinks is declining. It results in even more rise in atmospheric CO<sub>2</sub>. (Bharat Raj Singh, 2013)

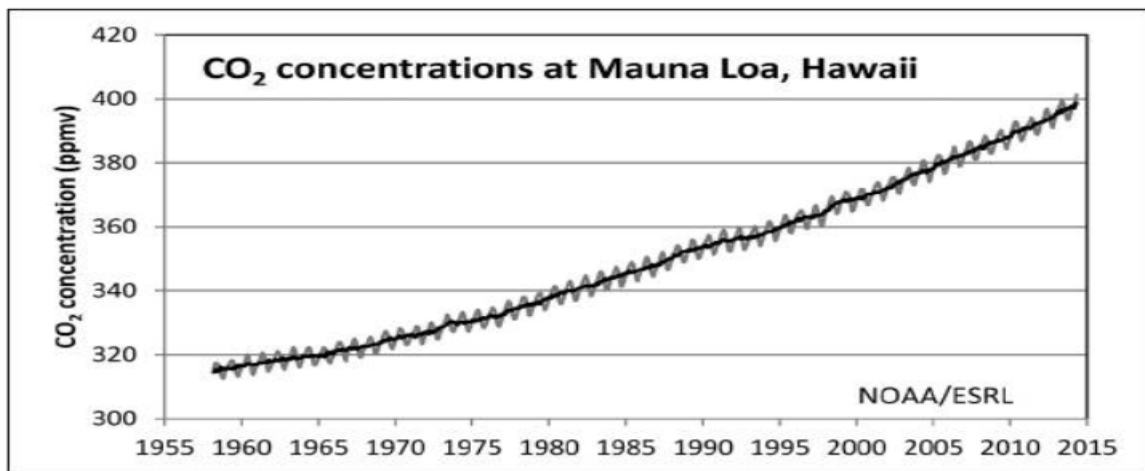


Figure 16: Illustrates CO<sub>2</sub> concentration in the atmosphere at Mauna Loa, Hawaii (source: NOAA/ESRL)

Extreme high temperatures were registered in 2015/2016 and years before. In 2016 the temperature was rising each month and at the same time there was the highest concentration of CO<sub>2</sub> in atmosphere.

CO<sub>2</sub> concentrations in the atmosphere were approximately 280 parts per million (ppm) and reached 390 ppm in 2013.

Estimations highlight that if it would not be reduced fossil fuels emissions CO<sub>2</sub> emissions will be at the level of 700-900 ppm by 2100. (Alexey Mikhaylov, 2020)

The situation is described as the biggest humanitarian crisis since the 2<sup>nd</sup> world war since globally people are the subject to food insecurity and safety problems.

In 1999 the G20 was established and the countries that joined it were: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico,

Russia, Saudi Arabia, South Africa, South Korea, Turkey, United Kingdom, United States, and the European Union.

Those countries are classified as “the world’s largest emitters” which stand for 80% of current greenhouse gas emissions, 85% of global GDP and 51% of the population are obliged to work on reduction of emissions through transition to renewable energy. The level of responsibility differs within the countries and is subject to UN Climate Change Convention. (Alexey Mikhaylov,2020)

G20 countries have a pivotal role in delivering global climate change regime.

The goal set up in the Paris Climate Change Agreement to limit global warming to 1.5 Celsius must be accompanied by reducing emissions.

However, Paris climate deal is the first step in the action to prohibit climate catastrophe. It is so called “game changer” since before that the world was on the way to extremely high level of emissions reaching 6 Celsius degree warming.

The second important date was November 2021 and the conference in Glasgow, Scotland, and climate pledges to remain below 2 Celsius degree and even to achieve net zero emissions by 2060. (Alexey Mikhaylov,2020)

Considering G20 and the rest of the world are moving in the direction of natural disasters. Figure below presents the trend how G20 and the rest of the world are developing from year 1990 and after.

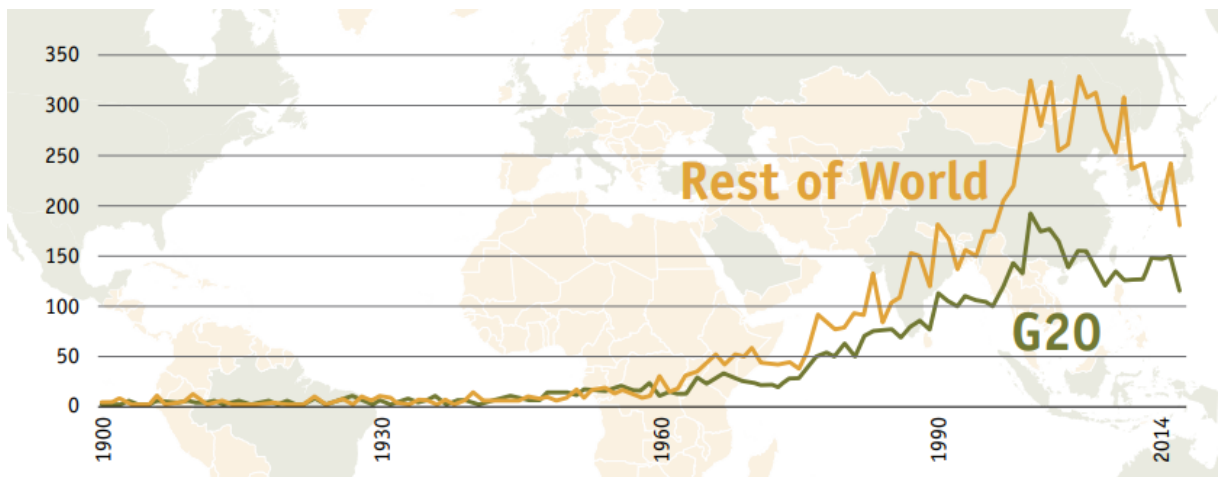


Figure 17: Illustrates number of natural disasters between 1900-2016

(<https://careclimatechange.org/wp-content/uploads/2017/06/G20-REPORT-.pdf>)

Natural disasters are exacerbated by climate change. Steep increase in natural disasters in G20 countries and the scenario for the future requires that G20 countries adapt to climate change and aim to zero-carbon infrastructure.



Scientists found out that there is a correlation between climate change and the probability of extreme weather conditions. (Bharat R. Singh, 2012)

The most dangerous climate changes can be avoided by transforming hydrocarbon-based energy systems and implementing adaptation programs. (Bharat R. Singh, 2012)

### **GHG in G20**

**GHG** Greenhouse effect stand for the main reason for climate change. (John P. Tiefenbacher, 2020).

Greenhouse gases are both occurring naturally and caused by the human activities.

The greenhouse effect is understood as the increase of the Earth's temperature caused by heating of the lower layers by the greenhouse gases. (Huang et al., 2016)

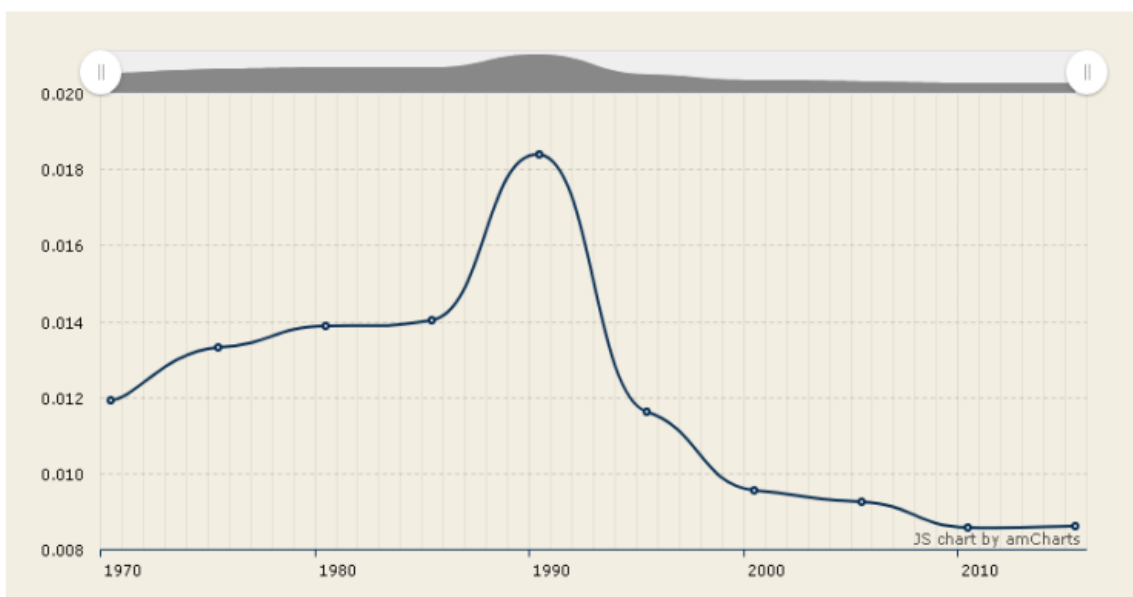


Figure 18: Illustrates total greenhouse gas emissions (source: John P. Tiefenbacher, 2020).

Jean Baptiste Joseph Fourier was one of the first presenting the mechanism of greenhouse effect and the influence on the Earth in the article: “A note on the temperature of the globe and other planets” in 1827. (Inamdar, 1994)

CO<sub>2</sub> associated with human activity is having the largest contribution to global warming.

Other gasses which have the influence on global warming are:

- Methane as a more powerful greenhouse gas than CO<sub>2</sub> has a shorter atmospheric lifetime.
- Nitrous oxide is a long-lived greenhouse gas like CO<sub>2</sub>.
- Fluorinated gases

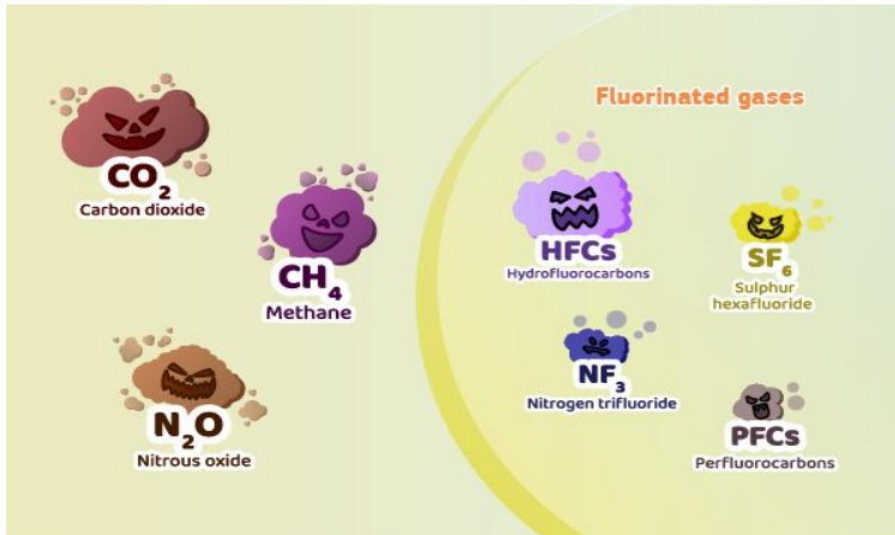


Figure 19: Illustrates greenhouse gases influencing global warming( source: [https://climate.ec.europa.eu/climate-change/causes-climate-change\\_en#greenhouse-gases](https://climate.ec.europa.eu/climate-change/causes-climate-change_en#greenhouse-gases))

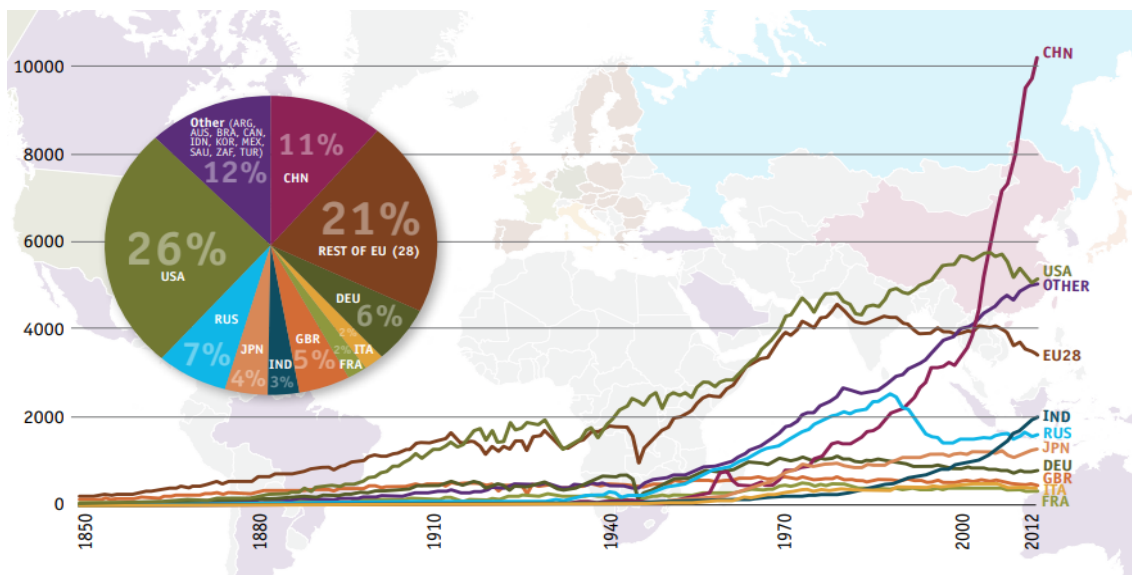


Figure 20: Illustrates CO<sub>2</sub> emissions from G20 countries from 1850-2013 (<https://careclimatechange.org/wp-content/uploads/2017/06/G20-REPORT-.pdf>)

G20 represent approximately 99% of historical CO<sub>2</sub> emissions (without considering land use). Therefore, it places a responsibility for G20 to mitigate climate change and contribute to helping others who suffer from inevitable impacts.

The US and the EU are the biggest emitters.

Considering steady increase in CO<sub>2</sub> emissions between 1850-213 G20 is responsible for transition to renewable energy.

Additionally, the increase in population requires the higher demand for food, housing and clothing. As a result of its industrial production is growing and pollution by the greenhouse gases are even bigger. (Levin, 2012; Li, 2017; Lisin, 2020)

The pursue of stopping global warming means that CO<sub>2</sub> emissions need to reach net zero globally. (Nigel Arnell, 2015).

### **3.1.1 The present state of climate change**

2019 year was the second warmest year and annual global temperature between 2014-2018 had been the warmest since 1880. Almost each year was 0.75-0.80 Celsius degree above the baseline mean.

Since year 2000 it was nearly every year that recorded hottest temperature.

The agreement signed by 195 states as Paris Agreement in 2016 did not help in improving the climate challenge and the carbon dioxide in atmosphere was increasing.

During March 2020 it was noticed that atmospheric CO<sub>2</sub> achieved 414 ppm.

The estimations are saying that the world is going toward a crisis at 1.5 Celsius grader warming by 2030.

The Kyoto Treaty had the aim to prevent 2.0 Celsius grader by the end of the century.

However current situation (slow progress) is giving chances to meet this objective by the year of 2050.

The issue of global warming is gaining curiosity. Countries such as America who perceived it as someone else's problem changed suddenly the attitude.

In the year of 2016, the United States had almost achieved the greenhouse gas output at the level as in 1990. The administration of Donald Trumf had contrary result and the level has increased by 4-5%.

The two European countries- The United Kingdom and Germany has made a progress in mitigating their national carbon footprints. In 2019 the United Kingdom had reduced the greenhouse gas 38% below the emissions in 1990. In 2018 Germany has managed to reduce emissions by 30% of the level in 1990.

Contrary to the nations which are making a great progress on the way to reduce emissions is China where emissions increased by 350% comparing its level in 1990.

Two countries- China and United States stand for 40% of the greenhouse gas burden.

According to IPCC limiting global warming to 1.5 Celsius grader requires reducing greenhouse gas emissions in 2030 and net zero CO2 emissions globally in 2050. (IPCC special report)

### 3.1.2 Anthropogenic warming

Garrett Hardin's and his concept "tragedy of the commons" enlighten humans' actions as responsible for the depletion of natural resources a compromise that last for years.

(R. Hahn et al., 2015)

Human-induced greenhouse effect is a challenge since it has a potential to warm the planet that has never been seen before. (K. Dennehy, 2018)

Those changes in natural systems since 1970 are noticed in the regions where temperature increases.

Increasing amount of CO2 emissions from deforestation and fossil fuel burning between 1970 and 2010 indicates almost doubled emission and higher increase between 2000-2010 than before. Additionally, human activity has also contributed to increased concentration of other greenhouse gases: methane, nitrous oxide, fluorinated gases, and halocarbons.

(Mundaca et al., 2018)

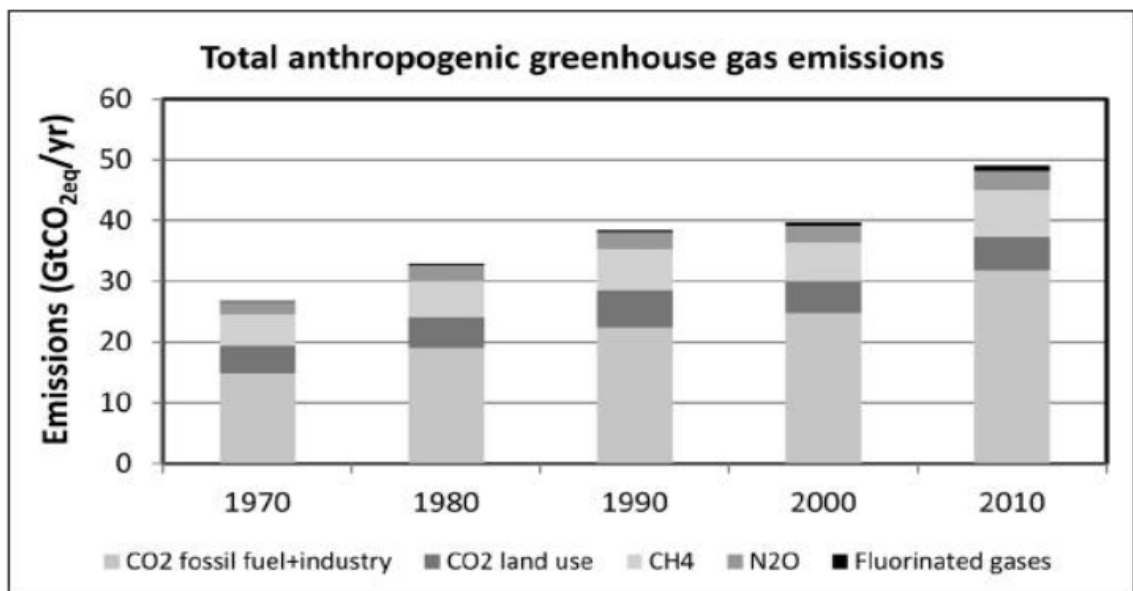


Figure 21: Illustrates anthropogenic emissions of greenhouse gases between 1970-2010 (sourced from IPCC AR5 Working Group III Summary for Policymakers)

The Intergovernmental Panel on Climate Change (IPCC) presented the fourth assessment report where they point out that increase in global average temperatures since the mid-twentieth century are caused by anthropogenic greenhouse gas concentrations.

According to IPCC and IPCC special report released in October 2018 global warming was at the level of 1 Celsius grader above pre-industrial level in 2017 and human induced activity added to additional 0.2 Celsius grader. (IPCC special report)

Consistently, anthropogenic climate change is influencing physical and biological systems globally.

The human's energy production is combined with fossil fuel combustion. Anthropogenic greenhouse gas emissions and global warming are linked to future energy production.

The Swedish Nobel prize laureate Arrhenius (1896) was one of the first one who investigated and created a theory on the CO<sub>2</sub> influence on earth's climate.

In the 1980's the World Meteorological Organization (WMO) and The United Nations Environment Program (UNEP) were working on the role of carbon dioxide and other emissions. In 1988 the IPCC organization was founded and the role of it was to discover the mankind's role in climate change.

Anthropogenic climate change is a complex problem caused by the interaction between-energy, economics, and environment. Energy is crucial for economic growth and development. However, is also main factor for mankind's emissions of GHGs. (Mikael Hook et al., 2013)

As to mention Nigeria and its oil industry stands for biggest source of global warming in the world. Gas flaring there is a concern globally. (R. Hahn, et al 2015)

IPCC suggests that climate adaptation is a rescue from the harmful effects that climate change can have. [75]

### **3.1.3 The future and scenarios for the climate change**

According to Nigel Arnell (2015) the future climate change is associated with uncertainties:

- We can't anticipate emissions of greenhouse gases since we can't predict economic development.
- The response of climate system on emissions is unknown.
- Climate system is characterized by internal variability.

The future of greenhouse gases is depending on the energy which is dependent on population growth and economic development.

- The International Energy Agency’s World Energy Outlook 2012 is anticipating the scenario of increase between 22 % to 45% by 2035 which is the topic of its Current and New Policy Scenarios.

Nigel Arnell (2015) shows four scenarios for the future emissions of carbon dioxide from the combustion of fossil fuels. It suggests that potential emissions from the burning of fossil fuel in 2050 may range from 11 to 20 billion tons of carbon per year. Thus, emissions would be 80% to 230% higher than in 1990.

The projection of future climate explained by these models depend on the change in forcing of the climate, the way the models represent climate processes and the initial conditions.

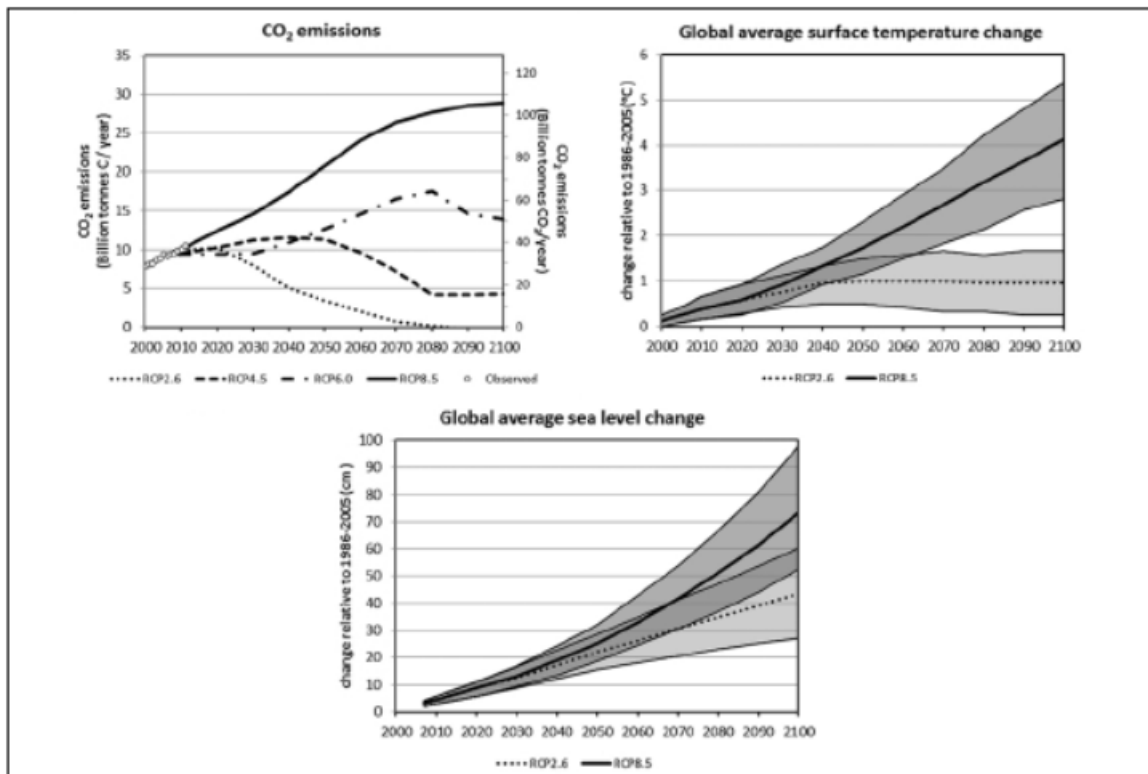


Figure 22: Illustrates potential change in CO<sub>2</sub> emissions, global average surface temperature change and sea level rise. Source: Global Carbon Budget 2013, IPCC AR5 Working Group I Summary for Policymakers

The estimate of future climate is dependent on the assumptions about emissions of greenhouse gases.

An increasing number of emissions has an influence not only on the climate and the weather but also on more water in the ocean. Over the 20<sup>th</sup> century the level has risen by 19cm.

### 3.1.4 GHG in Europe and South Korea

The share of global emissions from logistics and transport in 2015 is estimated as the second highest. (P. Wild, 2021)

Based on the Paris Climate Conference in 2015 and as part of the European Green Deal, the EU Commission (EU Commission, 2020) suggested to raise the greenhouse gas emission reductions and assumed:

- Minimum 40% cut in greenhouse gas emissions (from the state in 1990)
- Minimum 32% share for renewable energy
- Minimum 32.5% improvement in energy efficiency

According to IPCC (2013) GHG are having a long-lived influence with their tropospheric concentrations and radiative forcings.

The table 1 is presenting the list of GHG by IPCC where the most important GHG are: CO<sub>2</sub> and methane.

Table 1. Gases relevant

Gas	Alternate name	Formula	1998 level	Increase since 1750	Radiative forcing (Wm <sup>-2</sup> )	Specific heat at STP (J kg <sup>-1</sup> )
Carbon dioxide	Carbon Dioxide	(CO <sub>2</sub> )	365 µmol/mol	87 µmol/mol	1.46	0.819
Methane	Marsh gas	(CH <sub>4</sub> )	1,745 nmol/mol	1,045 nmol/mol	0.48	2.191
Nitrous oxide	Laughing gas	(N <sub>2</sub> O)	314 nmol/mol	44 nmol/mol	0.15	0.88
Tetrafluoromethane	Carbon tetrafluoride	(CF <sub>4</sub> )	80 pmol/mol	40 pmol/mol	0.003	1.33
Hexafluoroethane	Perfluoroethane	(C <sub>2</sub> F <sub>6</sub> )	3 pmol/mol	3 pmol/mol	0.001	0.067
Sulfur hexafluoride	Sulfur fluoride	(SF <sub>6</sub> )	4.2 pmol/mol	4.2 pmol/mol	0.002	0.074
HFC-23	Trifluoromethane	(CHF <sub>3</sub> )	14 pmol/mol	14 pmol/mol	0.002	0.064
HFC-134a	1,1,1,2-Tetrafluoroethane	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	7.5 pmol/mol	7.5 pmol/mol	0.001	0.007
HFC-152a	1,1-Difluoroethane	(C <sub>2</sub> H <sub>4</sub> F <sub>2</sub> )	0.5 pmol/mol	0.5 pmol/mol	0.000	0.04

Source: IPCC report (6 th assessment report)

Different authors in the literature have understated that the concentration of GHG in atmosphere is increasing and is caused by human activities. (Goetheer et al., 2010).

Negative impact of carbon emissions has been pointed out by Tan et al. (2022) on public health.

Additionally, acceleration of climate change experienced in the last decades of twentieth century (Dellink et al. 2014) are perceived as a threat to agricultural losses, sea level rise, negative economic consequences, and impacts on human health. (Kovats and Haines 1995)

### **3.1.5 Energy sustainability and transition to renewable energy**

Energy is critical to economic development and is linked to sustainable development (Mundaca et al., 2018)

For many years people have been struggling to utilize energy resources and fulfill their needs for food, warmth, shelter, and other needs.

(Smil, 1983)

Growing concerns of global climate change and scarcity of energy encouraged to sustainable energy transition.

Energy transition is pushing frontiers in energy modelling and frameworks with interdependencies between policy making, energy infrastructure expansion, market behavior, environmental impact and supply base. (Del Granado et al., 2018)

The sustainable energy transition is more than high- efficiency energy system. It considers environmental and social costs, risks and benefits and need to be done in a sustainable way. (Sareen and Haarstad, 2018)

There is interrelation between energy, resources, and environment. Energy system should not be assessed in isolation (del Granado et al, 2018)

## **3.2 Environmental benchmarking**

According to Dattakumar and Jagadeesh (2003) benchmarking is a tool for improving quality. (P. Hong, 2012)

The objective of benchmarking is to identify processes and performance outcomes of an outstanding organization with its competitors and compare processes and outcomes within organization in the changing environment. (Bemowski K., 1991)

Codling (1996) points out that benchmarking is the process of improving products, services, and practices in comparison to the best that are identified worldwide.

Many definitions of benchmarking have a common feature such as continuity, measurement, comparison, improvement to be in a better and superior position and achieve competitive advantage. (Camp R.C , 1995)



Benchmarking became a tool among companies in the 1980s and 1990s.

In the early 1990s, 65% of the Fortune 1000 organizations used benchmarking as a management tool to gain competitive advantage. (Foster, 1992)

(Szekely F., Vollmann T. and Ebbinghaus A., “Environmental benchmarking. Becoming green and competitive” Business and the Environment – Practitioner Series, Stanley Thornes Ltd., Cheltenham, 1996)

According to Szekely F et al., (1996) environmental benchmarking is an approach of analyzing processes from environmental perspective and supporting business activities. (European Environmental Benchmarking Network, Background, Fondazione Eni Enrico Mattei, 2000)

European Environmental Benchmarking Network points out that environmental benchmarking is a management tool for improving environmental performance by revealing a gap between company performance and given performance. ([Deanna H. Matthews , 2003](#))

Environmental benchmarking has the role for the organization to compare their performance across industries and their own facilities.

Comparing operations and selecting leaders and laggards in environmental performance enables companies to approach to effective solutions.

On the one side availability of common environmental data put restrictions on environmental benchmarking with competitors but on the other side it enables internal corporate benchmarking.

To organize internal corporate benchmarking an environmental management system (EMS) can be implemented (Matthews, 2003)

EMS aims to detect environmental burdens in the organization and to work with improvements by setting up policies, procedures, and protocols for reporting operations responsible for waste materials and emissions.

Many companies have implemented formal EMS as the ISO 14001.

### **Environmental management system (EMS) and ISO 14001**

Organizations developed EMS as a response to inadequate regulatory requirements for competitiveness and efforts directed to pollution prevention and controlling operations to be properly executed. (Wilson, C. , 1998)

EMS detects different activities and environmental burdens as well as provide a structure of activities fulfilling environmental requirements.

Implementing and maintain an EMS requires four step process. (Yosie, T, 1996)

:

- Plan for environmental compliance requirements
- Do to avoid environmental damage.
- Check that the plan is including all environmental issues.
- Act to improve the system.

ISO14000 is the most known EMS and series of standards on environmental management published by International Organization for Standardization (ISO, 1996).

The main document related to the whole system is ISO14001 Environmental Management System- Specification with Guidance to use. (ISO, 1996)

According to ISO organizations achieve benefits from implementing ISO EMS such as: reduced cost of waste management, savings in energy and materials use, lower cost of distribution as well as better image among regulators, customers and public. (ISO, 1998)

For corporate environmental benchmarking companies must take into consideration instructions given to facility leaders in implementing an EMS. The most focus should be on EMS elements providing information about environmental performance.

Each individual facility implementing EMS has different impact on environment.

However, organization should consider setting a common goal for benchmarking.

The adaptation of EMS for internal corporate environment benchmarking is important as it enables to manage environmental matters within organization.

### **3.3. Competitive environmental advantage**

According to Bonifant et al., (1995) environment related investments can lead to competitive advantage.

Michael Porter claims that although many companies are motivated to be better there would be few of them able to transform environmental investments into sources of competitive advantage. Clear strategy involves clear and unique position with different set of activities. Identifying sources of competitive advantage means distinguishing between products/services and processes within company.

In 1980 Michael Porter identified types of competitive advantage: low cost and differentiation. Porter perceives competitive advantage either in selling goods/products with the lowest cost or by unique features of products/services. (Michael Porter, 1980)

However, Resource Based View assumes that competitive advantage comes from ability of managing and acquiring resources. In other words, it comes from internal processes.

The ISO14000 series of EMS certification is the follower of ISO 9000 series of Total Quality Management. (TQM) Quality oriented management enhanced competitiveness. Moreover, focus on identifying problems resulted in minimizing or eliminating trade-offs between costs and quality.

Principles of TQM can be adapted to the management of corporate environmental and social responsibility or so-called Total Responsibility Management (TRM).

Companies have potentials to gain from environmental investments since most of the companies gain success through intangibles. The arising attention of customers to societal and environmental responsibility is their shopping behaviors.

Considering competitive environmental strategies companies can have different competitive focus depending on the structure of the industry it operates in, the type of markets it serves and its capabilities.



Figure 23: Illustrates competitive environmental strategies (source: Michael Porter, 1980)

Strategy 1 : *Eco- Efficiency* Porter and Claas van der Linde claim (Michael Porter, Claas van der Linde, 1995) that resource productivity should be enhanced, companies should take advantage of profits from environmental investments and transform them to sources of competitive advantage.

Strategy 2: *Beyond compliance leadership* are companies which aim to increase efficiency and they want customers and stakeholders to notice those efforts. Companies like these invest money in certification of their EMS, invest in environmental investments.

Strategy 3: *Eco-branding* means differentiation based on the environmental attributes of products.

*Strategy 4: Environmental Cost leadership* ecologically oriented product cost more and this differentiation strategy is the way to pay off for the ecological investments.

Managers need to prioritize environmental investments and connect them with strategy of the company. The framework presented in figure shows areas of organizational actions, help in obtaining optimal economic return on environmental investments and as a result transform them as a source of competitive advantage.

### **3.4 Back shoring and offshoring- sustainability**

Since 1990s location of activities in a foreign country independently of governance mode – offshoring had been popular as a strategy implemented by Western manufacturing companies to achieve competitive advantage. (Contractor et al., 2010)

Definition of offshoring refers to relocation of value chain activities outside companies headquarter (Bals, Jensen Moeller-Larsen&Pedersen, 2013) and provides make or buy decision. (Jahns, Hartmann&Bals, 2006)

Companies often choose offshoring due to cost advantage and proximity to customers. (Londsdale and Cox (2000); Kakabadse (2002).

However, outsourcing has been questioned whether it is a good strategy. (Stentoft et al., 2015).

Ethical and environmental issues can affect sales of global organizations. Limitations to control supply chains is a challenge.

Developed country governments experienced hits to their economic competitiveness and health. As a response to these forces some companies started to re-think carefully their supply-chains. (Wiesmann et al., 2017)

Additionally, disruptions caused by effects of pandemics and geopolitical crisis have revealed vulnerability of global supply networks. (Andres Fernandez- Miguel et al., 2022)

The new trend has emerged, and companies started bringing production back to home countries. (Di Mauro et al., 2018, Fratocchi et al., 2014)

This trend is referred to as back-shoring (Kinkel, 2012; Canham and Hamilton, 2013) or reshoring/near-shoring (Gray et al., 2013; Tate,2014, Fratocchi et al., 2016)

This strategy are responses of manufacturing companies to disruptions to adapt to unforeseen events. (Andres Fernandez- Miguel et al., 2022)

**Reshoring/back shoring/near shoring** is defined as:

*“the relocation of value creation tasks from offshore to geographically closer locations [...] irrespective of the ownership mode”* (Foerstl et al., 2016: 495).”

The question arises “why do firms backshore”? The analysis of motivations aims to reveal whether de-internalization is more goal oriented. (Benito, 2015)

Value creation and capture have changed, and companies were forced to reinvest processes, organizational models, products, and business models in a sustainable way. (D’Adamo et al. 2021)

Considering unforeseen events companies aim to diversify supply sources and create supply chains which are resilient, agile, and flexible and green. (Miceli A et al, 2021)

Additionally, it is important to build supply chains with the aim of reducing carbon footprints. (Ahmadini AA.H et al, 2021)

Moreover, the goal is to reduce the carbon footprints of supply chains. (Ahmadini A.A.H, 2021)

There is a great number of motivations proposed in the literature. (Bals et al., 2016, Foerstl et al., 2016, Fratocchi et al., 2016, Stentoft et al., 2016a)

One of the hypotheses was that back shoring occurred because of managerial challenges - bad planning and insufficient knowledge of the offshore location. (Kinkel and Maloca, 2009)

According to A. Fernandez (2022) back-shoring (near shoring) can reduce supply risk and has a positive impact on the environment.

Another hypothesis was based on the rising total costs in the offshore such as ownership in China and lower energy costs in the West. (Martínez3.3-Mora and Merino, 2014, Simchi-Levi et al., 2012, Tate et al., 2014).

According to Manning (2014) back shoring came as a reply to complex challenges by offshore production.

The fact is that offshoring of manufacturing goods demands higher transportation needs and this affect pollution problem. (Cadarso et al, 2010)

Last motivation is associated with customers preferences and the need to get the products of higher quality made by western productions. (Ancarani et al., 2015, Fratocchi et al., 2016, Grappi et al., 2015, Martínez-Mora and Merino, 2014, Robinson and Hsieh, 2016, Tate et al., 2014).

Manufacturing companies are dependent on the location where the company procure raw materials, process them, and turns them to finished products to the customer. The

significance of location is connected to developing strategic plans by the company and its competitive strategy. (Puig F, et al 2022)

Manufacturing companies are those who tend to move production from established to emerging countries to cut cost or reap advantage of sales prospects.

**Offshoring** is defined by manufacturing outside companies headquarter. (Ellram et al., 2013)

Definition includes value chain activities which have been moved from home country to another as well as those established abroad or purchased from abroad. (Wiesmann et al., 2017)

Offshoring is a phenomenon which had been connected to globalization, economic integration, and openness to international trade. (Krieger- Boden C, 2013)

It is a technique used to adapt to changes in the competitive environment and gain competitive advantage. (Chen Q, 2021)

In the short-term offshoring can reduce production costs but in the long term it increases the risk of losing control of operations. (Baldwin R, 2013)

One of the main factors for choosing offshoring was the labor cost. However, the disparity/gap in labor costs between the West and emerging nations has been narrowed. These nations' labor and environmental laws have been related to those of industrialized nations. (Yu U.J, Kim J. H , 2018)

Therefore, reconsidering of offshored industry occurred. Domestic production had been implemented to re-industrialize developed economies. (Fratocchi L, 2014)

Sometimes there are obstacles to bring business back home as unavailable raw material at home or too expensive investment to copy manufacturing facilities.

While the theoretical part of manufacturing offshoring is excessive, when it comes to back shoring it is more limited. However, researchers did not explore strategic alternatives for input sourcing practices (Van Hoek R.,2021) and green supplier selection (Puška, A, 2022).

According to Internalization Theory back shoring is a response to changing characteristics of world economy such as increasing costs of managing ownership abroad or reduced value of local specialization. (Casson,2013)

Another theory -Dunning's eclectic paradigm claims that back shoring appeared in the light of deterioration of offshore location advantages. (Dachs and Kinkel, 2013)

According to Ellram et al., (2013) backshoring decisions are dependent on changing conditions of either home or host location.

Gylling et al., (2015) suggests backshoring because of changes not only outside organization but also within it. One of the examples could be productivity improvement.

### **3.5 Transaction-Cost Theory and Resource Based Theory**

Transaction-Cost Theory (Williamson, 1975) and Resource Based Theory (Barney,1991) explain backshoring from strategic management point of view.

TCE (*Transaction Cost Theory*) perceive backshoring as driven by higher control and coordination costs of global supply chain. (Kinkel and Maloca, 2009, Martínez-Mora and Merino, 2014).

Transaction cost is helping in decision making whether outsourcing or in housing production while taking into consideration total costs. (Walker, 1984- Walker, G., & Weber, D. (1984). A transaction cost approach to make-or-buy decisions. *Administrative science quarterly*, 373-391)

Historically companies were choosing offshore production as there were lower transactional costs – lower wages and less regulations (Farrell, 2006) It has been done by vertical integration with companies possessing factories abroad or through external suppliers. (Langlois, 1992)

TCT's approach has a microanalytical perspective and it enlightens the importance of asset specificity. It assesses the potential of resources to adapt to various purposes. (Riordan, 1985)

Considering the goal to best utilize resources in respect of cost and effectiveness TCT focus on automation and digitalization. (Manyika et al., 2017)

Transactional costs occur between two or more parties interacting together and relation between them determines cost. However, there are few factors to consider when talking about relationship between parties. (Tadelis 2002)

Amongst them are:

- Rational uncertainty and limited rationality of individuals
- Opportunism and hold-up problem from external partners
- Asset specificity and limited number of possible suppliers

According to RBV (*Resource Based Theory*) backshoring could be encouraged by inability to control resources abroad or/and limitations to exploit the host's country resourced and gaining competitive advantage. (Canham and Hamilton, 2013).

Companies aim to differentiate themselves and as a result gain a competitive advantage.

One of the theories that is essential part for companies' competitive advantage and performance is resource-based theory. (Barney et al., 2011)

The competitive advantage explains why some companies are more profitable and are more successful than competitors while operating in the same industry and having same resources. (Petts, 1997)

Comparing to another theories RBT uses in internal perspective and explains company's success or failure. (Wernerfelt, 1984)

Recently Bals et al. (2016) proposed integration of theoretical perspectives on production relocation with Critical Incident Theory (Flanagan, 1954, Gremler, 2004); relational view (Dyer and Singh, 1998), absorptive capacity and the firm's learning orientation (Calantone et al., 2002; Levitt and March, 1988); organizational buying behavior (OBB) (Robinson et al., 1967).

### **3.6 Corporate Social Responsibility**

#### **Corporate Social Responsibility (CSR)**

CSR is reflected in doing the right things and do it better. (Bhattacharya and Sen, 2004)

CSR is perceived to be necessary to define organization's role in society as well as apply ethical and social standards. (Lichtenstein et al., 2004)

Some companies are demonstrating commitment to CSR (Pinkston and Carroll, 1994) but some are struggling. (Lindgreen et al., 2009)

CSR activities are often used in positioning corporate brand to consumers and other stakeholders and communicating them through annual reports (Sweeney and Coughlan, 2008) or websites.

CSR communication emphasizes the crucial role of social and environmental reporting (known as CSR framework) and two-way communication process to include stakeholders.

### **3.7 Corporate Strategies for Managing Climate Risks (Climate related strategies)**

Climate change is an issue relevant for organizations in private and public sectors. It has an influence on the way the company is using the energy, the way it is exposed to risk and is a source of opportunities. (Mundaca et al. ,2018)



There are some areas of risk from climate change which can affect the organizations:

- Operational as it can have the influence on cost or ability of doing business.
- Supply chains and procurement as supply chain can be at risk.
- Market as it can change the demand for the products/services.
- Regulatory as regulations can either stimulate or limit companies' activity.
- Reputation as company's attitude to the issue of climate change can affect its reputation.

According to Nigel Arnell (2015) organizations can respond to the climate risk by reducing the concentration of greenhouse gases in atmosphere known as "mitigation". Another approach is to adjust and take advantage of new possibilities known as "adaptation". Often organizations response to climate change has elements of both mitigation and adaptation and sometimes measures of them can conflict with each other. As the fact is that climate means and increase in frequency and strength of extreme weather events have a negative for many countries and regions there is a need to implement adaptation strategies. (e.g., Green *et al.*, 2010; Miles, Elsner, Littell, Binder and Lettenmaier, 2010; Hallegatte *et al.*, 2011; Winn, Kirchgeorg, Griffiths, Linnenluecke and Günther, 2011; Linnenluecke, Griffiths and Winn, 2012).

Literature on organizational theory has focused on the optimal fit existing between organization and its surrounding environment. Organization is seen as operating within an external and independent environment. (Smircich and Stubbart, 1985)

Considering changing external environment contingency theory suggests ideas:

- There is no single way to manage organizations.

The design of organization must fit with the organization's environment.

Contingency theory assumes that optimal organizational performance is following internal and external factors and constraints. (Tosi and Slocum, 1984)

Contingency theory assumes that the company needs to acknowledge changing external environment and adapt to it. Emphasis in this theory is on the relationship between uncertainty of the "task environment" and organizational characteristics (Tosi and Slocum, 1984).

Dess and Beard (1984) suggested three dimensions of organizational task environment: munificence, dynamism, and complexity. Munificence refers to environment for growth and stability, dynamism is associated with unpredictability of environmental change, complexity relates to range of different organizational activities (Dess and Beard, 1984) They are important since affect and stimulate changes in organizations. (Damanpour and Evan, 1984).

The analysis of task environment and uncertainties is significant since poor fit can negatively affect organizational performance. (Pennings, 1992; Gaunic and Eisenhardt, 1994)

The literature on adaptation to climate change has evolved and there are many typologies that have been suggested. (Smit, Burton, Klein and Street, 1999; Smit, Burton, Klein and Wandel, 2000; Arnell and Delaney, 2006; Nitkin, Foster and Medalye, 2009).

Smit (2000) introduced the “analogy of adaptation” to distinguish differentiating approaches and states questions:

- Adapt to what?
- Who or what adapts?
- How does adaptation occur?

Smit et al. (2000) emphasizes that in the first question there is a need to finding out which climate changes can affect companies and organizations must adapt to. Sources of those impacts can be related to continued changes of climate means as well as increasing frequency of extreme weather events. (IPCC, 2007)

Physical effects of climate change can result in positive and negative way on a company's business activities.

Considering negative physical effects of climate change, it relates to companies' value chain:

Primary impact i.e., companies' internal business activities

Secondary impacts i.e., impacts on suppliers, infrastructure.

The exposure to the climate risk depends on the industrial sector in which a company operates. Vulnerable industries are those where companies are dependent on seasonal and climate conditions and those vulnerable to infrastructure disruptions. (Winn and Kirchgeorg, 2005).

Company’s exposure may also differ considering the geographical location it operates in as climate can vary regionally (IPCC, 2007)

Physical effects of climate change can affect up and downstream activities along value chain and as a result change customers product / service preference (SPRU/Tyndall Centre, 2003; Chegini, 2005)

Climate change can have negative impact on corporate business activities. Those can be selected as the following value chain activities:

- Resource supply
- Production
- Product distribution

Source	Impact of climate change	Impact occurs to		
		Resource supply	Production	Product distribution
Schwartz (2007)	• Disrupted commerce and transport	X		X
	• Power outages	X		
	• Shortages of water	X		X
Sussman and Freed (2008)	• Damages to assets	X		X
	• Lower effectiveness and efficiency of production processes		X	
	• Higher costs for operations & maintenance activities	X	X	X
	• Decreased quality and quantity of natural resources and raw materials	X		
	• Decreased quality and quantity of other necessary production inputs	X		
	• Change in customers' demand for goods and services	X	X	X
	• Slower/disrupted supply of inputs	X		
	• Slower/disrupted customer access to product			X
	• Disrupted electric and water supply	X		
	van Bergen <i>et al.</i> (2008)	• Damage to property	X	X
• Enforced relocation of operation		X	X	X

Figure 21: Illustrates negative impacts of climate change on corporate value chain activities (source: “Corporate Strategies for Managing Climate Risks” Georg Weinhofer and Timo Busch, 2013)

Companies are dependent on secure supply of necessary resources, infrastructure and climate conditions. (Winn and Kirchgeorg, 2005; BVI, 2007; Lash and Wellington, 2007).

In case of disruption of those condition companies are suffering from conducting their business and it is required to respond in a proper way to avoid negative consequences. (Pennings, 1992; Galunic and Eisenhardt, 1994; Winn *et al.*, 2011; Linnenluecke *et al.*, 2012).

As most negative (climate related) impacts on business activities are subject to uncertainty companies can’t implement all-in and wide-scale adaptation strategy. As a solution organization can implement risk management while adapting to climate changing conditions.

A report published by Economics of Climate Adaptation Working Group (ECA, 2009) underlines the significance of addressing climate risks properly from a societal point of view. From organizational point managers should consider the importance of the risk they are exposed to (Porter and Reinhardt, 2007; Romilly,2007) and manage climate risks to the extent of management's beliefs. (Berkhout *et al.*,2006; Bleda and Shackley,2008; Hoffmann, Trautmann and Hamprecht,2009)

Companies have restricted knowledge of climatic changes, and they cope with uncertainty about exposure to impacts on their business activities. Management can anticipate some changes to occur in the future but there are some changes difficult to anticipate.

Considering the complexity of the predicting process, adaptation to climate change is seen as uncertain for businesses.

Berkhout et al. (2006) and Dovers and Hezri (2010) suggest that managers could choose a passive role. It means that they should not take any actions to adapt to climate change.

According to them since there is uncertainty about some negative business impacts managers could rather implement a wait and see strategy.

Hoffmann, Trautmann and Hamprecht (2009) point out that if organization perceive climate change as material issue for business it would not choose to wait and see strategy but initiate adaptation measures.

Corporate management of climate risk according to Merna and Al-Thani (2008) is a set of measures to address negative impacts imposed on business activities from climate change.

In response to changing climate corporation can implement various approaches and strategies.

Climate change presents two challenges:

Avoiding the unmanageable caused by increasing greenhouse gas emissions.

Managing the unavoidable that is already observed and anticipated in the future (Friedman, 2008)

Those challenges are challenges for the society, companies should consider them from the risk management perspective.

Moreover, companies need to have two-dimensional risk perspective: look "inside-out" which mean impact on business activities while working with climate change and "outside out" seen as impact of changing climate can have on their business activities. (Winn and Kirchgeorg, 2005, Porter and Reinhardt, 2007).

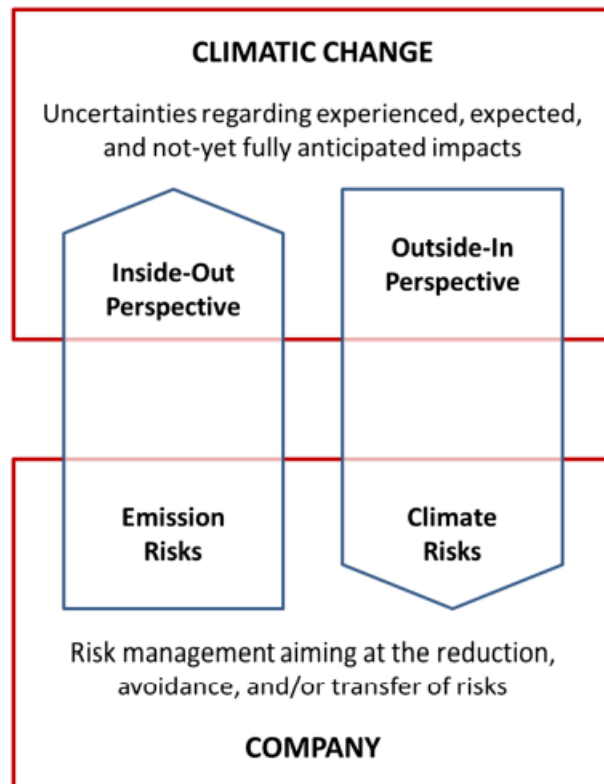


Figure 25: Illustrates companies two-dimensional risk perspective on climate change source: “Corporate Strategies for Managing Climate Risks” Georg Weinhofer and Timo Busch, 2013)

In 1987 the World Commission on Environment and Development published “Our Common Future” and the concept of sustainable development. From this time sustainable development for the business was common as it highlighted the benefits such as low operational cost and “license to operate”.

The World Business Council on Sustainable Development published a vision for 2050 and the way to sustainability. (Dellink Rob, Elisa Lanzi, Jean Château, Francesco Bosello, Ramiro Parrado, Kelly C De Bruin, 2014)

### 3.8 Empirical review

An empirical literature is presented to show what have been done in relation to research problem and what was the findings.

Different authors were using approaches to back shoring as a sustainable solution.

This part of the literature review outlines related research covering topics and authors summarized in table 2.

Table 2. Publications on environmental sustainability as a back- shoring motivation

Publication (number in Appendix)	Motivation/ Driver											
	Sustainability (without further specifications)	Business objectives in terms of environmental and social sustainability	Environmental and social sustainability	Eco-sustainability	Environmental problems	Implementation of environmental and ethical standards	Carbon labeling	Carbon footprint	Need to stop taking advantage of the permissive foreign environmental regulations	Adoption of CSR strategies that lead to selecting suppliers that are more environmentally friendly and socially responsible	Cleaner production processes performed by the suppliers of the host countries	Increase customers' awareness of environmental problems
1												
2												
3		X										
4												
5												
6			X									
7					X							
8	X										X	
9	X											
10										X		
11			X									
12												
13				X								
14								X				
15			X				X					
16												
17	X											
18	X											
19												
20	X				X			X				
21	X											X
22						X						
23												
24								X				X
25	X											
26			X									
27					X			X				
28	X											
29	X											
30	X											
31	X				X							
32	X				X							
33					X							
Tot.	12	1	4	1	6	1	1	3	1	1	1	2

Source: Cristina di Stefano, Luciano Fratocchi Manufacturing back-shoring and sustainability: a literature review

## Appendix: Publication

#	Author(s)	Year	Journal/ Book chapter	Environ, sustainability	Social sustainability
1	Abbasi	2016	Journal of Textile and Apparel Technology and Management	X	
2	Ashby	2016	Operations Management Research	X	X
3	Barbieri <i>et al.</i>	2018	Journal of Global Operation and Strategic Sourcing	X	X
4	Bals <i>et al.</i>	2016	Operations Management Research	X	X
5	Denning	2013	Strategy and Leadership	X	X
6	Di Mauro <i>et al.</i>	2018	Journal of Purchasing and Supply Management	X	X
7	Ellram <i>et al.</i>	2013	Journal of Supply chain Management	X	X
8	Engström <i>et al.</i>	2018a	Journal of Global Operation and Strategic Sourcing	X	X
9	Engström <i>et al.</i>	2018b	World Review of Intermodal Transportation Research	X	X
10	Fel and Griette	2017	Strategic direction	X	X
11	Foerstl <i>et al.</i>	2016	Journal of Physical Distribution and Logistics Management	X	X
12	Fratocchi <i>et al.</i>	2014b	Book chapter	X	X
13	Fratocchi <i>et al.</i>	2015	Book chapter	X	X
14	Fratocchi <i>et al.</i>	2016	Journal of Physical Distribution and Logistics Management		X
15	Fratocchi	2018	World Review of Intermodal Transportation Research	X	
16	Grappi <i>et al.</i>	2015	Journal of the Academy of Marketing Science	X	X
17	Gray <i>et al.</i>	2013	Journal of Supply chain Management	X	X
18	Gray <i>et al.</i>	2017	Journal of Operation Management	X	X
19	Heikkilä <i>et al.</i>	2018	Journal of Manufacturing Technology Management	X	X
20	Moore <i>et al.</i>	2018	Journal of Manufacturing Technology Management	X	X
21	Moradlou and Backhouse	2016	Journal of Engineering Manufacturing	X	
22	Pal <i>et al.</i>	2018	The International Journal of Logistic Management	X	X
23	Robinson and Hsieh	2016	Operations Management Research	X	X
24	Sirilertsuwan <i>et al.</i>	2018	The International Journal of Logistic Management		
25	Srai and Ané	2016	International Journal of Production Research	X	X
26	Stentoft <i>et al.</i>	2015	Supply chain Forum: An International Journal	X	X
27	Stentoft <i>et al.</i>	2016a	Operations Management Research	X	X
28	Stentoft <i>et al.</i>	2016b	Operations Management Research	X	X
29	Tate	2014	Journal of Purchasing and Supply Management	X	X
30	Tate <i>et al.</i>	2014	Business Horizons	X	X
31	Uluskan <i>et al.</i>	2017	Journal of the Textile Institute	X	X
32	Wiesmann <i>et al.</i>	2017	European Business review	X	X
33	Zhai <i>et al.</i>	2016	Operations Management Research	X	
Total				28	25

The above summary shows how researchers have addressed the issue of back shoring in different ways.

According to authors: Akyelken and Keller (2014) offshoring and global sourcing are changing the geographical distribution of production activities which have impact on environment.

Sawhney and Rastogi (2015) points out the issue of the polluting industries which are choosing production activities where environmental legislation is less severe.

The fact is that stringent European regulations are minimalizing contaminating emissions. On the other hand, offshoring and the creation of longer supply chains are increasing global emissions.

It is pointed out that positive result economically is not always associated with social and environmental sustainability.

According to Milberg (2008) offshoring can contribute to income disparities in the world. Since 2007 scholars paid attention to the phenomenon of back shoring.

Wiesmann et al, (2016) points out back shoring as a complex decision caused by different elements.

On the one hand are the drivers of the phenomenon that were extensively analyzed during many years, on the other hands are barriers which are paid less attention to. (Engström et al., 2018).

Stentoft et al. (2016) suggests drivers as: cost, quality, time and flexibility, access to knowledge and skills, risks and other factors.

Fratocchi et al. (2016) proposes back shoring motivations classified according to the environment they belong to: internal vs external and strategic goals: value creation vs cost reduction.

Barbieri et al. (2018) suggest that back-shoring should be investigated more since there is little research on this field.

Three literature reviews between 2016 and 2018: Wiesmann et al. (2016), Stentoft et al.(2016 a) and Barbieri et al. (2018) explore back shoring.

Barbieri et al. (2018) as one of the recent literature reviews focuses on the role of environmental and social sustainability pillars. Furthermore, such pillars may influence decision-making process:

- Motivation/driver: role of environmental and social sustainability for back shoring decision
- Outcome: is related to verifying whether the choice to repatriate productive activities regardless of the reasons has an influence on the company's environmental and social sustainability



- Barrier/enabling factor: the research has a goal to explain whether environmental and social sustainability can be an obstacle or rather contribute to back-shoring decision.

Scholars have usually conceptualized sustainability as a motivation while less focus had been paid to more specific elements as adaptation of carbon footprints certifications or the role of customers and suppliers in manufacturing sustainability.

When considering the documents, they can be grouped to:

- Documents that consider sustainability as a business strategy
- Documents assessing the role of actors outside the firm.
- Documents referring to the legislation in the country of origin.

The first group mentioned above relate especially to implementation of environmental standards as carbon footprint and protecting environment in not choosing the mildest environmental legislation in off-shoring countries.

Considering the second group which highlight the role of actors outside the company there are four documents promoting sustainability. According to Ashby (2016) back-shoring is a recommended strategy in complex, long term relationship.

Two documents refer to the role of consumers in environmental and social sustainability. Lastly is the document referring to the role of legislation in offshoring country regarding the reduction of pollution and the working conditions of employees.

However, when considering social pillar there is a special advantage in terms of unemployment reduction in the home country.

Scholars often treat sustainability issue as something more than just a stand – alone result of the relocation. (Heikkilä et al., 2018b, Johanson et al., 2018; Stentoft et al., 2018)

However, at this point of the chapter where all important areas of the study have been discussed, a summary of the various sections is developed below.

### **3.9 Chapter summary**

Nowadays backshoring is growing at a slow pace (Eurofound, 2016) across most European countries.

According to Fratocchi et al (2014) there are differences at the country level.

Michael Porter said: “(...) *a lot of CEOs offshored too quickly and too much*” (The Economist, 2013) and it was right.

Backshoring can be understood considering overestimated expected advantages and underestimated production costs. Additionally, massive offshoring contributed to the increase of labor costs in destination countries.

Backshoring drivers often coincide with those connected to offshoring but in the opposite direction.

The determinants include the following:

- Differences in environmental footprint or sustainability
- Increases in labor costs
- Productivity constraints
- Scarcity of skilled staff
- Lack of innovation
- Difficulties of protecting intellectual property
- Lower quality standards
- Lack of flexibility and government incentives

Successful measures for back shoring strategy must be multifaceted.

Firstly, it is necessary to ensure national based or back shored competitive advantages to firms. (Porter, 2011) Governments should provide cost benefits through incentive policies and broader strategy which is fostering competitiveness. (Ricciardi et al., 2015)

Secondly, intelligent specialization is necessary in activities where developed countries have competitive advantages in a globalized world. It means emphasizing the national prestige of knowledge-intensive activities and industries with long tradition and an image of quality.

New phenomenon-near shoring is emerging and is expected to grow. Ongoing debate between keeping production abroad and moving it back home gives rise to nearshoring which combines advantages of those both strategies.

The next chapter presents the findings of this study.

#### **4. Findings and analysis**

The findings are based on the transcribed interviews analyzed and presented in this chapter.

The analysis when it comes to the responses of the experts were categorized under backshoring and offshoring and the interaction between both shifts and environmental sustainability.

The questions for the interviews were deliberately open-ended so participants could freely discuss other related topics.

The analysis is starting with presenting the background of the interviewed participants.

## **4.1 Qualitative analysis**

### **4.1.1 Background of experts**

As we can see in the interview guides (Appendix A, Appendix C, Appendix E) questions enlighten the background of the researcher. All experts have a significant experience in the field of climate sustainability and the equivalent strategies of back shoring/reshoring/near shoring and offshoring.

**Respondent 1 (Res 1) (Tommy J-Project manager)** is a project manager at NOV.

He has been working in NOV for 21 years. He has experience within technical design, sales engineering, management of customer relationship and orders, warranty supervision, project engineering of offshore installations and lately project management.

Today Tommy has the role in NOV to ensure that when getting the contract for the crane - to take it from the sales team and deliver the crane to customer on time and to the correct price of course. The price is fixed for the crane costs.

**Respondent 2 (Res 2) (Terje K – Project director Lifting&Handling)** is a project director lifting & handling NOV.

He has been working in NOV for several years. He has experience as a director of operations, lifting& handling, and management of HR.

Terje has the responsibility is when the contract with the customer is signed and is handed over to project to follow up that it is delivered accordingly.

**Respondent 3 (Res 3) (Ronny H-Product line manager)** a product manager at NOV.

He has been working as a product manager for over 4 years in NOV and is managing NOV's global portfolios of lifting and handling equipment for various applications such as

cranes, winch systems and pipe/cable lay. He is responsible for commercialization of new products and technology.

He has experience also within structural calculations in the Lifting& Handling segment. Additionally, Ronny has experience while working also to other companies as a project manager for Woodside Energy, department manager (Pipelines and Analyses) for IKM Ocean Design Australia Pty Ltd, senior pipeline engineer for IKM Ocean Design AS, Offshore engineer for Standard Engineering AS or sales manager for Eniro Norge AS.

This background analysis shows that all the three experts interviewed had a significant level of experience and knowledge within the field of climatic sustainability.

All three interviews were conducted digitally at Teams one week before Easter time. (April 2023) The choice of the respondents was based on the relevance according to the master topic and the aim was to choose people whose daily decisions have influence on the issue of climatic emissions of case study project- Jotun. I had a plan to send those interviews to the verification to the respondents but due to lack of time it was unfortunately impossible to conduct.

#### **4.1.2 Backshoring and reducing CO2 emissions.**

Different questions were asked related to the drivers which motivates production in Europe with respect to environmental footprints.

The collected responses from the experts included: benefits of producing in Europe, main challenges and obstacles, main actors involved, the impact of backshoring and the perspectives of backshoring in Europe.

##### **The perspectives of back shoring for NOV**

On the question: “What do you think are the perspectives of back shoring for NOV?”

Res1 reflected that : *“I have been working for NOV 20 years so for me the challenge is that I don’t have so much background of how it could have been because all I know about this is that we have always done like this but obviously if we in the future find a facility in Europe that would build cranes for us that would be something that we would need to outsource and I don’t think it’s a goal for us to buy a facility in Europe to do it. We would probably be going to outsourcing to a European facility to build something. So if*

*immediately for me as a project manager I think I would say that if it was for me to choose if I would prefer to use NOV Korea or outsource building in an external company in Europe regardless of shipping cost etc I would definitely choose the Korean factory because it's my colleagues I know them and its of course much more convenient for me to have a known factory which have built the cranes several times before and they know what they need to do with the shipment and the drawing and some months later (six months later) it's a finished product.”*

Conclusion is that Tommy perceives more value in still manufacturing in Korea comparing to a long process of adapting to European facility and outsourcing it to European actor . Experience with Korea is an important factor.

Res2 pointed out that: *“a lot of cranes that we are delivering are supposed to be installed in a yard either in Singapore or China or somewhere in Asia.*

*We see that there are more and more cranes coming into Europe for instance Jotun or cranes like that.*

*We also see that the construction market which it's for instance Solstad and so on which are by the Norwegian coast moved to Norway.*

*Then for the big picture building cranes in Asia and sending them by boat all the way to Norway that's not a very green way to do it.*

*Therefore, we see that we need a fabrication facility in Europe, so we don't have to send all those cranes all the round the world.*

*I am working to facilitate it together with supply chain within NOV – that's one thing. “*

Res2 pointed that today more customers are placed in f ex Norway and therefore there is a need for evaluating manufacturing in Europe and closer to the end user.

### **The benefits of back-shoring**

Back shoring as a sourcing strategy has a potential to reduce emissions significantly.

On the question:

“Which are the main benefits with back-shoring strategy? Is environment a decision factor?

(Do you believe that back shoring could help to reduce emissions (GHG emission)? If answer is yes – please be so kind and explain how?)”

Res3 answered that:” *If we are talking about bringing these kinds of projects back to for instance Norway or at least immediate areas we would be doing so because we would reduce cost for transportation, reduce emissions from transportations, we will have political incentives for bringing work back to Norway so there are all positives.* “

Res3 stated that the advantage of moving production closer to end user is savings due to lower cost of transportation, reducing emissions from transportation and social incentives such as moving back workplaces to Norway (home country).

On the other question of:” *However, do you think choosing back shoring strategy for NOV would give competitive advantage?”*

Res 2 stated that back shoring is contributing to competitive advantage since the total price of delivering the crane to the customer in Europe and producing it in Europe would be lower and additionally climatic emissions of this is lower : *“Yes of course because today the freight of the crane from Korea to Europe probably is at the cost of 1 million dollar. We have the consumer saying that we have competitors but produce crane in Europe then if everything else is equal then they will be able to send the crane cheaper than us. But we also know that most of the consumers if we are talking about consumption market so day in east banks of China use most of the projects.*

*We know that in the future banks will offer cheaper loans if they would provide good vessel. We can have consumer and offer European made crane with lower CO2 emissions and helping the customer saying: ok this is a crane with a lower footprint than another crane.”*

Res3 claims that back shoring would not contribute to the competitive advantage of the company since transportation costs are yet low: *“No- not at that stage. I don’t think so. The reason for that is that when it comes to transportation it’s too cheap.*

*If we would say that transportation contract could pay a certain CO2 tax for everything that is transported, I think we would see quite different grades of bringing the contract back to our work.”*

### **Main challenges / obstacles for back-shoring**

On the question of “Which are the main challenges of back-shoring for NOV” responders answered as following:

Res 1 pointed out the challenges of back-shoring such as struggling when it comes to costs and often occurring conflicts between outsourcing company and the need of the customer:

*“I am aware that in the future we would have (and it would be hard to avoid it) a European alternative of building the cranes but in my mind I am quite sure that it would be an external company that we would outsource the building to that and I am confident to say that it will cost a lot of more work for the project manager because it’s not just following the normal process of doing this. It means that we would need to have an external company to do things for us and it will always be a struggle to have built what we have agreed on to the price we have agreed because using things internally it’s never a discussion about cost.*

*Discussions about cost is easier to have internally because it’s with your colleagues and within the company.”*

Res 2 stated that there are differences in customers’ preferences in Norway contrary to Asian market: *“I can start with the challenges. As most of the industry especially oil and gas industry are very much driven by cost. To have a success in implementing fex fabrication which have a lower footprint -it’s very much up to the customer. Ok?*

*If our customer is a Yard in China, they don’t care about the environment.*

*You can imagine it’s a big yard with mainly Chinese employees and as I see it focusing on greener environment is also a matter of living standards. Do you agree?*

*In Norway living standards are quite high so we can afford to those kinds of choices.*

*If you live fex east in China -you really don’t care because you have so many other problems to deal with first.*

*So, if our customer is a yard in China then everything is about cost. On the other side if our customer is a Norwegian oil company which is on the other end of the scale we can use as an illustration Equinor which has a very good sense of responsibility, so we must start with those customers that see the value in making a lower environmental footprint.”*

Res 3 suggested that cost is still a main factor that plays role in oil industry and NOV aim to be competitive when it comes to price: *“We have had the model until 2014 when we fabricated for instance from Poland and shipped to Norway and back but there is a reason why it stopped and again it is due to costs. It’s a market that has a fairly strong competition. So, if we unable to meet our competitors’ level of price tag and we offer more expensive products and the customer value the quality and product execution model that we can bring to the table but still cost is an important factor.”*

Additionally, Res 3 stated out that it is important that the customer value high environmental investments and actions of NOV elsewhere it would be efforts that are worthwhile : *“That was the point that I was touching when it comes to facilities, fabrication perspectives and so on. We have done a lot of research into that. There are fabrications in Poland, Lithuania and even in Norway. In Norway we have a couple of them where we could bring up to be fully functioning fabrications.*

*However even if we are already as a supplier what is even more important is that our customers are willing and ready to see the benefits from their perspectives and be willing to join us on the journey to take extra perceived costs, so it depends also on how their value that reduces CO2 emissions for instance.”*

### **Main stakeholders and the significance of reducing CO2 emissions.**

On the question “How do you think third parties ( f ex customers) perceive the significance of reducing CO2 emissions and implementing back-shoring for the future?”

Res 1 stated that customer’s preferences for CO2 reduction is a case that Sales team is involved in and it can be a factor that decides on that NOV get the contract because it can provide the product with the important advantage for the society : *“I am not into those discussions with the customers directly and I am fully aware that our Sales team are preferring those kinds of situations where environmental footprint is even as important for the customer as the price.*

*Going back 20 years ago or 10 years back or 5 years back the only thing that mattered was price – price and quality. When it comes to quality, they would have to get high*



*quality from NOV. We are aware of the fact that our price is not low, but the reputation of NOV is high -we are delivering top product for its price.*

*In the future I am quite sure that deciding a supplier will more and more be demanding and the supplier that could give us good, green environmental footprint.*

*That is already a discussion with the customers but not from my level but rather from the sales team because now my job starts the contract decides. It's the process prior deciding the contract.*

*It might be that at a certain level we would end up losing the contract because we don't have good enough environmental footprint of the factory building the crane in Korea comparing the competitors that will build a crane in Europe. "*

Res 2 pointed out that customers need to be able to choose a solution that is better for them and pay the price for it and NOV should know what customer prefers. NOV should listen to the customer: *"let me say that we assume firstly that we have two fabrication concepts. We can say that if you are using concept A then the cost is some and we can have environmental footprint on this machine of a number and then we can compare it and say ok concept B is having 10% higher cost, but we save the environment since it has lower environmental emissions.*

*Then the next step would be that the customer chooses which one he wants. We must be able to have a consumer that get the cost of the crane f ex 5 mill dollars with the CO2 emissions.*

*However, the consumer can prefer an alternative of smaller emissions at a higher cost. We must be able to listen to the consumer. That's the dilemma because often and that's also with Jotun case the consumer is not always an end user since its often a yard. A crane is a small piece on a bigger vessel. That's a challenge.*

*If the consumer is a yard in China, they will always go for the lower price. "*

Additionally on the question: *"if customers ask about documentations about CO2 emissions and standards when it comes to climatic influence."*

Res1 stated that when it comes to documentation about CO2 emissions from customer perspective at the project level it is not a requirement but at the management and sales perspective things change and NOV is working on it in order to get the strength in the light of competitors:

*"At the project level I have no project that this is a requirement.*

*I think from the management level or sales perspectives I am quite sure that they need to fill some kind of documentation.*

*I have a feeling that today it is not a requirement, but the customer is asking for it for some kind of information or at least to check if we have considered it.*

*I don't think that today we have a strict requirement to it and I don't think we are able to do it either but we are working on it now.*

*Considering the values that I was asking my colleagues to get to you if we were in a position to give that immediately it would be easier for me to say that we have control of them but considering the fact that I need to check it I don't think we have it."*

Res2 pointed out that today there are no requirements for documentation considering CO2 emissions but he perceives it as a big advantage for the future of the company:

*"Very little expectations from the customers. I don't think that industry has made it ready yet so that's one of the things we are discussing and has started working on.*

*If the industry could set a standard and provide those answers to the customers before they even, ask about it -that would give us advantage (comparing our competitors).*

*However, it is hardly ever asked."*

### **Factors that should be considered when implementing back shoring strategy.**

On the question regarding "Which other factors should be considered while implementing back-shoring in NOV?"

Res1 stated that the experience and knowledge in the field is an important factor for NOV and that is why he prefers still NOV Korea comparing to outsourcing production for European actor: *"I don't have so much background of how it could have been because all I know about this is that we have always done like this but obviously if we in the future find a facility in Europe that would build cranes for us that would be something that we would need to outsource and I don't think it's a goal for us to buy a facility in Europe to do it. We would probably be going to outsourcing to a European facility to build something. So if immediately for me as a project manager I think I would say that if it was for me to choose if I would prefer to use NOV Korea or outsource building in an external company in Europe regardless of shipping cost etc I would definitely choose the Korean factory because it's my colleagues I know them and its of course much more convenient for me to have a known factory which have built the cranes several times before and they know what*

*they need to do with the shipment and the drawing and some months later (six months later) it's a finished product."*

Res 1 also added that it is most likely that NOV would outsource the production to European company but he believes that it will take more time and resources: *"Of course I am aware that in the future we would have (and it would be hard to avoid it) a European alternative of building the cranes but in my mind I am quite sure that it would be an external company that we would outsource the building to that and I am confident to say that it will cost a lot of more work for the project manager because it's not just following the normal process of doing this. It means that we would need to have an external company to do things for us and it will always be a struggle to have built what we have agreed on to the price we have agreed because using things internally it's never a discussion about cost."*

Tommy (res 1) had also pointed that when it comes to the project there are often decided some criteria which need to be followed:

*"It's boring answer but obviously considering we are the part of the company- NOV it's to all our responsibility to ensure that we follow certain criteria but I find it quite challenging because obviously this discussion now building a crane in Korea with parts shipped from Europe but shipping the crane back again I am not feeling any direct situation to change it because our supplier is in Europe -that's the pattern of our design and our design is prompt suppliers in Europe. We use sub stab suppliers specific deliver suppliers, and we need to use them, and we are building the crane in Korea. I cannot start a new factory of course but obviously have you been trying me to be aware and affect this situation of course.*

*Yes- I have a possibility to affect how we are doing things but for the project we need to deliver what the Sales have been promising to the customer and for the Jotun project it was already included in the contract that we were going to build the crane in Korea and ship it back to Norway. Then it's kind of impossible to make any changes to this specific project. "*

Res 2 stated that NOV aims for sustainable solutions and since producing the crane in South Korea and sending it to Norway seems to be a solutions that is not a "green one" fabrication facility in Europe is more and more advantageous:" *For the big picture building cranes in Asia and sending them by boat all the way to Norway that's not a very green way to do it.*

*Therefore, we see that we need a fabrication facility in Europe, so we don't have to send all those cranes all the round the world.*

*I am working to facilitate it together with supply chain within NOV – that's one thing. “*

Additionally, res 2 is willing to listen to the needs of the customer and is saying that NOV could even start the process of finding a European actor who could produce the crane if only the customer would insist on that : *“NOV Korea it's a part of our company and its our colleagues. If we are going to produce a crane in Europe than we need a third party. (vendor)*

*I think if we had a customer today and say that: ok we are going to buy a crane from you, but it has to be produced in Europe then we would been able to do it today. “*

Res 1 believes in back-shoring and its strength in disruption times since delivery time is a problem for many companies: *“It's some projects with a lot of need regarding delivery time and of course it's much easier to do a priority internally with the company which is our colleagues, and we could discuss.*

*Many of our suppliers that we have as reliable for this period now they need to be kind to all their customers. It's not like that that we are always on the top of the priority list for big suppliers with Europe like Siemens or Bosch Electro etc . We like to consider ourselves as a very big and important customer but for the companies like Siemens they have a lot of customers that are much bigger than NOV.*

*When we try to push them and say that this is important to have, and we need to have this tomorrow they will of course politely say that yes, they understand and do whatever they can, but I get the feeling that it is impossible.”*

Another question that was asked was: *“Could you say that back-shoring is a good alternative in disruptions times with long lead time?”*

Res1 pointed out that: *“Yes, I would agree on that because it's some projects with a lot of need regarding delivery time and of course it's much easier to do a priority internally with the company which is our colleagues, and we could discuss.*

*Many of our suppliers that we have as reliable for this period now they need to be kind to all their customers. It's not like that that we are always on the top of the priority list for big suppliers with Europe like Siemens or Bosch Electro etc . We like to consider ourselves*

*as a very big and important customer but for the companies like Siemens they have a lot of customers that are much bigger than NOV.*

*When we try to push them and say that this is important to have, and we need to have this tomorrow they will of course politely say that yes, they understand and do whatever they can, but I get the feeling that it is impossible.*

*Having the back-sourcing than to do it ourselves it's of course easier to prioritize what's important project for ourselves.*

*If we today had a European facility that are building some of the cranes that we are going to deliver now I think the delivery situation could be much more challenging if we were building the crane in Europe with the external company instead of the situation that we just manage to handle in our company in Korea. It's our colleagues and we can find solutions together with them."*

Res 2 added that disruptions are the reasons for higher prices of the products and affect availability of them : *"Disruptions – such as COVID 19, and the political war between Ukraine and Russia were affecting the lead time and the whole industry has experienced it. It's especially on electro components but we also see that the cost is higher because of the disruptions. Everything is getting more expensive."*

### **4.1.3 Outsourcing and CO2 emissions**

Different questions were asked which related to production in South Korea

#### **Reasons of outsourcing**

On the question:" Could you tell me what the reasons of outsourcing was?"

Res 1 answered about the reasons of outsourcing in the times when South Korea where the place that NOV used implementing outsourcing and it was made mainly due to the cost factor. :

*"At the start that we used this factory in Korea it was not a NOV factory. We outsourced it because of cost. I can confirm that my opinion was also that it is only due to cost.*

*Obviously, we observed more and more products delivering in Korea. Its two sides of it.*

*Many years ago we needed a facility in Korea to deliver cranes in Korea but we needed to go from three or two facilities down to one. I think Korea was chosen because of cost."*

Res3 pointed out that the most important is that if producing overseas the need is to be sure that the facility is never idle : *“Geographically speaking if it would be producing overseas the benefits is simply that we can make sure that that facility is filled is filled with projects at any time -they are not running out of jobs meaning that facility is never idle. Idle facility is very expensive-that is a problem.”*

### **Challenges of outsourcing**

On the question: “Do you experience any challenges while outsourcing such as language barrier, communication, quality, holding control and fulfilling?” expectations?”

Res 1 stated out that production in South Korea has a benefit such as finding common solutions : *“If we today had a European facility that are building some of the cranes that we are going to deliver now I think the delivery situation could be much more challenging if we were building the crane in Europe with the external company instead of the situation that we just manage to handle in our company in Korea. It’s our colleagues and we can find solutions together with them.”*

Res2 commented that the quality of the product delivered from NOV varies in China from Norwegian standards: *“South Korea is our own company back to 2008 its 15 years ago but I have been to yard where our equipment is installed on a vessel in China and of course you see things that you don’t want to see.*

*That’s on the yards that are maybe our customers.*

*So of course, in China I saw things that are not of our standards. (Things that don’t cover our high standards)”*

Res 3 answered that there is a still a challenge with language barriers but it becomes smaller. However communication between technicians is more complicated : *“It is a language barrier, but it diminishes over time and having worked for some time. Initially the barrier was higher.*

*It is communication at certain level. If you have engineers talking to each other can be more challenging than speaking to your neighbor in the office.*

*It is also the challenge about the control level. You need to how the think and respond.*

*I understand what my colleagues are saying but communication is not as ideal as it could be.”*

Res 3 added also that NOV should create an organizations which encourages learning process of new talents and to share the knowledge internally in the company: *“We have engineers who design the crane -the system, framework, control system -they are too seldom perhaps able to see the crane in distance and for crane purposes we need new talent to organizations and learning them about the crane . There is a office in Norway and the actual crane is building in Korea.*

*It makes more challenges in groups to work together.”*

#### **4.1.4 Back-shoring and offshoring and interactions between them**

##### **Back shoring versus offshoring**

Res 1 pointed out that : *“A couple of years ago during the downsizing of organization the development of the market ended up with no production facilities in Europe and the only production facility we still have left is Korea. However, NOV branded it as NOV factory so it’s our factory and at the time being it’s the only factory that we have but still produce the cranes that we are designing in Norway.*

*Of course, NOV is a big company with a lot of different equipment so the factory in Korea is also producing products for other NOV facilities that I don’t even know about because my only thing I think about is cranes.*

*Obviously, we are doing the production in Korea but some of the cranes that we are selling today is going to be delivered to an oil company in Norway. That’s where the challenges start of course considering the environmental footprint and cost of production etc. Many of the competitors have production facilities in Europe.”*

Res 1 also added that: *“I need to say it first because many of our projects today is going to be delivered to a shipyard in Korea and it’s Singapore or maybe somewhere like there and for those projects it’s not a problem to produce a crane in Korea. We are still highly focused on the market in Norway, but the North Sea is of course very big and important part that we deliver to.*

*I think the study you are doing is mainly related to where we have a delivery to the customer in Norway. If the customer wants the crane to be delivered to Korea obviously, we will not produce it in Europe.”*

Res 1 also expressed which solution between back shoring and outsourcing he prefers:

*“So if immediately for me as a project manager I think I would say that if it was for me to choose if I would prefer to use NOV Korea or outsource building in an external company in Europe regardless of shipping cost etc I would definitely choose the Korean factory because it’s my colleagues I know them and its of course much more convenient for me to have a known factory which have built the cranes several times before and they know what they need to do with the shipment and the drawing and some months later (six months later) it’s a finished product.*

*But of course I am aware that in the future we would have (and it would be hard to avoid it) a European alternative of building the cranes but in my mind I am quite sure that it would be an external company that we would outsource the building to that and I am confident to say that it will cost a lot of more work for the project manager because it’s not just following the normal process of doing this. It means that we would need to have an external company to do things for us and it will always be a struggle to have built what we have agreed on to the price we have agreed because using things internally it’s never a discussion about cost.”*

### **The effect of the Russian invasion of Ukraine**

In this section there is a focus on Russian invasion of Ukraine and how it will effect on implementing and development of sourcing strategy- back shoring.

On the question if back shoring is a good solution in disruption times all experts agreed that it is absolutely a good way to solve the problem of delivery times (lead times).

It is a common challenge for suppliers to deliver products on time and as the competition.

## **4.2 Quantitative analysis**

This analysis applies to an all-electric offshore crane produced by NOV.

The aim is to identify the Greenhouse Gas (GHG) footprint of all- electric offshore crane and evaluate scenario to relocate manufacturing from South Korea to Europe to compare the GHG impact of relocating facilities within a cradle-to-grave system boundary.

In this system aftermarket, service and repair are not considered.



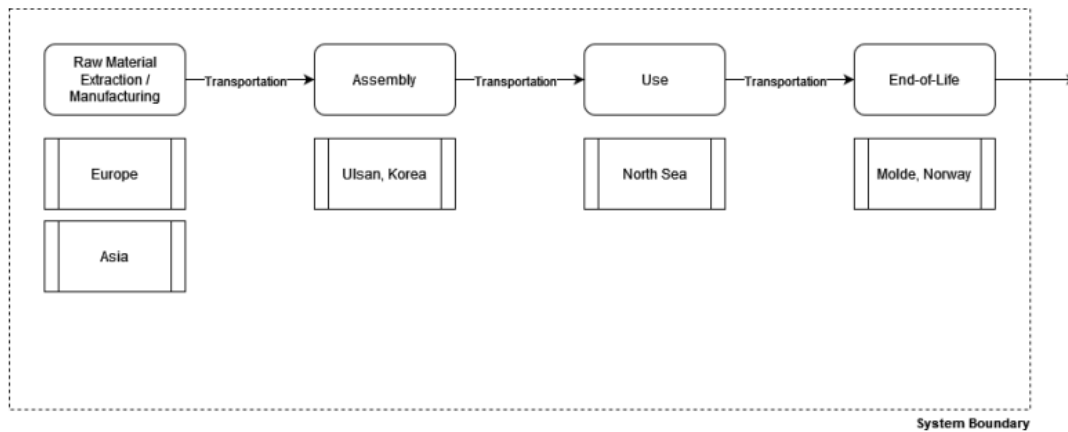


Figure 23: Illustrates system boundaries

The Life Cycle Inventory is based on : the calculation sheet, bill of materials, technical specifications provided by NOV.

Consulted companies in the case study were NOV Norway and NOV Korea.

Suppliers and companies are: Distribution NOW, Siemens, Oswald Elektromototen GmbH, Shilla Precision and AF Decom.

The reason for conducting this analysis is to address customer inquiry and market demand for project bid life cycle inclusions. Additionally, NOV would find out product's GHG footprint to announce future plans when it comes to reducing overall GHG footprint of the product and align with the UN Sustainable Development Goals (SDGs) indicators.

There are some assumptions due to time constraints, budget limit and system boundary.

These assumptions are:

Impact Sources	Assumptions
Transportation of materials or parts	Transportation is based on kilometers (km) from the city location or city port location, depending on modal type (truck or ship).
Mass contribution	Mass contribution is solely based on a weight analysis provided by NOV (Document EQ-15605-111A-N-RD-102).
Shipping frame mass	Mass contribution for the shipping frame is 10 tons of carbon steel, per an NOV engineer. This value has not been verified.
Site locations	Site locations were provided by NOV in its cities and were used for identifying transportation routes.
Electricity consumption during fabrication & assembly	Electricity consumption during fabrication & assembly was provided by the NOV Korea facility.
Electricity consumption during use	Electricity consumption during use was assumed to be 400 MWh over a 25-year lifespan, based off a representative operational profile from LCA OC3000 Operational Footprint.
Waste disposal and recycling rates	Waste disposal and recycling rates were taken from an LCA study on steel construction, manifests provided by AF Decom, and recycling rates from AF Decom's recycling receivers Stena Recycling, Celsa Nordic, and Norscrap Karmoy.

Table 3 Illustrates principal assumptions

The analysis excludes the following:

- Mass contribution on a part-specific level based on the product Bill of Materials
- Supplier part specifications for the majority of supplier parts in the Bill of Materials, except Draka electrical cables and Oswald electric motors
- Transportation during loading/unloading of parts -forklifts, medium-duty trucks and light-duty vehicles
  - Supplier-specific transportation of materials/parts from supplier location to NOV assembly location
  - Transport of materials /parts within a port
  - Manufacturing site transport of materials /parts
- Manufacturing and industrial processes during procurement and assembly as welding, extruding, molding
- Computing electronics used in the product, batteries and byproducts.
- Day-to-day operations of the crane over product life, barring electricity
- Maintenance, repairs, upkeep of the crane during lifetime
- GHG emissions from industrial use of water during material procurement and manufacturing process

- GHG emissions from energy use during decommissioning of the crane to transporting to recycling facilities.
- Disposal of hazardous materials and waste
- Utilities' at the supplier, site and disposal, barring electricity

## Life Cycle Inventory

This is an analysis conducted by NOV in cooperation with bsi group. In this section life cycle modeling of the all-electric offshore crane utilized the GaBi software and lifecycle database.

GaBi software is a software used to evaluate the environmental impacts of various products, technologies, services and systems. It is sustainability and environmental solution for the company which enables evaluate and optimize the environmental impact of its products. The main aim of this solution is to set up sustainability goals and meet up the industry regulations.

Elements of these is described in detail.

Data used in this section are primary and secondary data, mass contribution calculations, adopted assumptions, data gaps.

### Raw material extraction and manufacturing

This life cycle covers material procurement and manufacturing of parts. All datasets were taken from GaBi to match parts from the mass contribution.

The majority of materials was procured from the European Union (EU/EU-28) and a minority of steel from Asia.

Individual GaBi datasheet for each dataset is as follows:

*Steel Wire Rod* The EU: Steel wire rod (2019) worldsteel dataset was substituted for steel wire rope/steel rope.

5,909 kg of steel wire rod was selected to represent 48 kg of Steel rope and 5,861 kg of steel wire rope.

*Steel Welded Pipe* The EU: Steel welded pipe (2019) worldsteel dataset was substituted for steel pipe. 2,000 kg of steel welded pipe were selected to represent 2,000 kg of steel pipe

*Steel Plate* The EU: Steel plate (2019) worldsteel dataset was substituted for primary steel. 143,146 kg of steel plate were selected to represent 99,912 kg of primary steel; 18,000 kg of the Machine House; 1,485 kg of the Driver's cabin foundation; 10,000 kg of the Shipping Frame; 13,749 kg of the Main, Whip and Luffing winches

*Paint emulsion* The EU-28: Paint emulsion (building, interior, white, wear resistant) dataset was substituted for paint. 839,25 kg of Emulsion paint were selected to represent 25% of the total miscellaneous mass (3,357 kg).

*Aluminium Steel Mix* The EU-28: Aluminium sheet mix dataset was substituted for aluminium in the Driver's Cabin. 2,126 kg of aluminium sheet were selected to represent 2,126 kg of the Driver's cabin

*Grey Cast Iron (GG) Part* The DE: Grey cast iron part dataset was substituted for cast iron parts in the electric motors. 1,180 kg of cast iron parts were selected to represent 1,180 kg of the electric motors.

*Asia: Steel Engineering Steel Worldsteel* The Asia: Steel Engineering steel worldsteel dataset was substituted for the steel. 11,948 kg of Asian Engineering Steel were selected to represent 3,000 kg of the Gear Box; 61 kg of the Slewing machinery hoses; 1,075 kg of the Lower bolts connections, Slewing ring; 1,123 kg of the Upper bolt connections, Slewing ring and 6,689 kg of the Slewing ring. Engineering steel are sourced from Asia.

*EU-28: Cable 3 Wire (EN15804 A1-A3)* The EU-28: Cable 3 wire dataset was substituted for the Draka Electrical cables. 27.2 kg of the Cable 3 wire were selected to represent 27.2 kg of the Draka electrical cables.

*EU-28: Cable 5 Wire (EN15804 A1-A3)* The EU-28: Cable 5 wire (EN15804 A1-A3) dataset was substituted for the remaining electrical cables. 1,332.8 kg of the Cable 5 wire were selected to represent 134 kg of the Electrical cable trays; 522 kg of the Electrical-lights and 704 kg of the Electrical cables.

*EU-28: Stainless-Steel Sheet (EN15804 A1-A3)*: The EU-28: Stainless steel sheet (EN15804 A1-A3) dataset was substituted for the stainless-steel screws. 1,783.5 kg of the Stainless-steel sheet were selected to represent 05 kg of the electric motors and 50% of the total miscellaneous mass (3,357 kg)

*DE: Steel Cast Part Alloyed (Automotive)*: The DE: Steel cast part alloyed dataset was substituted for the steel found in the electric motors. 1,600 kg of the steel cast automotive parts were selected to represent 1,600 kg of the steel in the electric motors. Due to GaBi : DE: Electricity grid mix 1kV-60kV and DE: Thermal energy from natural gas were utilized

*EU-28: Copper Wire Mix (Europe 2015)* The EU- 28: Copper Wire Mix (Europe 2015) dataset was substituted for copper wire found in the electric motors. 335 kg of Copper Wire Mix were selected to represent 335 kg of copper in the electric motors.

*EU-28: Fluorescent Lamp T8 36W* The EU-28: Fluorescent lamp T8 36W dataset was substituted for the lights and aviation lights. 115 kg of fluorescent lamp were selected to represent 105 kg of lights and 10kg of Aviation.

*EU-28: Lubricants at Refinery:* The EU-28: Lubricants at Refinery dataset was substituted for the Fluids. 170 kg of Lubricants were selected to represent 170 kg of fluids.

*Welding Seam:* The welding seam process was substituted for the welds. 839.25 kg of the welding seams were selected to represent 25% of the total miscellaneous mass (3,357 kg)

### **Transportation**

Multiple phases have been divided in GaBi model. Primary form of transportation is intermodal shipping. Secondary transportation methods are omitted. Distances are taken from mapping resources Rome2Rio and SeaRoutes.

*Transport to NOV Korea for Assembly:* European -supplied parts are situated in Paldiski (Estonia). European parts are shipped separately by truck 8,710 km to the port of Tianjin in China. The GLO: truck, Euro 3, 28-32 t gross weight dataset was selected to represent this form of transportation. The trucks are fueled by diesel; the EU-28: Diesel mix at filling station dataset represents fuel source.

At the port of Tianjin including Asian steel are shipped separately by container ship 1,397 km to Ulsan in Korea. The GLO: Container ship, 5,000 to 200,000 dwt payload capacity, ocean going dataset was selected. The ships are fueled by heavy fuel oil; the GB : Heavy fuel oil at refinery (1.0 wt % S) dataset represents fuel source.

*Transport to customer installation site for assembly to an offshore site:* After assembly in Ulsan in Korea, the crane is shipped 21,263 km to the customer installation site located in Molde in Norway by Suez Canal for final assembly. After that, the crane is shipped 726 km to the North Sea for crane use. Container ship and heavy fuel oil datasets were selected. The ship has a deadweight of 12,578 kg.

*Transport to end-of-life disposal:* After use in the North Sea , the crane is shipped back to Molde in Norway (726 km) for end-of-life disposal. Container ship and heavy fuel oil datasets are selected.

### **Crane Assembly**

Assembly of the crane is located in Ulsan at the NOV Korea site.

*Crane assembly at NOV Korea:*

A custom dataset was created with the inputs for all materials and parts as well as electricity and the output of it is one electric crane weighting 173,351 kg.

Flows	Quantities	Amount	Units
Aluminum sheet (anodized) [Metals]	Mass	2126	kg
Cast iron part machined (GG) [Metal parts]	Mass	1180	kg
Copper cable 5-wire [Electrical installation]	Mass	1332.8	kg
Copper wire (Cu; 0.06mm) [Metals]	Mass	335	kg
Draka Electrical Cables [Metals]	Mass	27.2	kg
Electricity [Electric power]	Energy (net calorific value)	401972	MJ
Exterior paint [Minerals]	Mass	839.25	kg
Fluorescent lamp [Lighting]	Mass	115	kg
Hydraulic oil [Operating materials]	Mass	170	kg
Stainless steel screw [Metals]	Mass	1783.5	kg
Steel cast part (machined) [Metal parts]	Mass	1600	kg
Steel part [Metal parts]	Mass	11948	kg
Steel pipe [Metals]	Mass	2000	kg
Steel plate [Metals]	Mass	143146	kg
Steel wire [Metals]	Mass	5909	kg
Welding seam [Others]	Length	31083.3	m

Table 4 Illustrates input flows for crane assembly dataset

*Electricity use:* Electricity for crane fabrication and assembly was provided by NOV Korea. Electricity is assumed to be 111,659 kWh for the fabrication and assembly. The JP: Electricity grid mix 1kV-60kV dataset was selected to represent electricity grid at this facility.

**Use phase:** The use phase of the crane takes place in the North Sea at an unknown site. An average location in the sea was selected using SeaRoutes.

*Electric crane use phase:* A custom dataset, use phase-crane operation was created to represent the use phase of the crane. Inputs were the electric crane and electricity. The output was the electric crane.

Electricity for the use phase was assumed to 400 MWh over a 25-year lifespan.

The NO: Electricity grid mix 1kV-60kV dataset was selected to represent electricity grid at this facility and require power from shore connections to the site.

**End of life :** End-of-life disposal and recycling takes place in Molde in Norway at unknown sites. Additional transport to these facilities were omitted in the analysis.

The crane is separated into aluminum scrap, copper scrap, glass scrap, stainless-steel scrap, steel scrap and landfill. Glass scrap was omitted in this analysis due to insufficient data.

Waste disposal and recycling rates were taken from study on steel construction, provided by AF Decom.

The recycling rates were: 95% aluminum recycling, 80% copper recycling, 90% stainless-steel recycling, 89.3% steel recycling with a 98% delivery rate.

**Separation into waste streams:** The custom dataset end-of-life crane was created to represent the end-of-life phase of the crane. The input was the electric crane. Outputs were aluminum scrap, copper scrap, stainless-steel scrap, steel scrap and landfill.

Flows	Quantities	Amount	Units
Aluminum scrap [Waste for recovery]	Mass	1979.3	kg
Copper scrap [Waste for recovery]	Mass	1328.9	kg
Landfill [Waste for disposal]	Mass	25766.1	kg
Stainless steel scrap [Waste for recovery]	Mass	1573.0	kg
Steel scrap [Waste for recovery]	Mass	142703.7	kg

Table 5: Output flows for End-of-life crane dataset

*Waste to disposal:* The remaining mass of the crane, 25,766.1 kg was selected as landfill.

*Waste to be recycled:* The mass of the crane being recycled is: 1,979.3 kg of aluminum; 1,328.9 kg of copper; 1,573.0 kg of stainless steel; 142,703.7 kg of steel.

**Life cycle impact assessment:**

Global Warming Potential (GWP) for the all-electric crane is 743,509 or 7.43E005 kg CO<sub>2</sub>e.

The main contributor to GWP is during the raw material extraction and procurement phase-61%. Transportation represent 22%. Fabrication and assembly, use and end-of-life have smaller impacts.

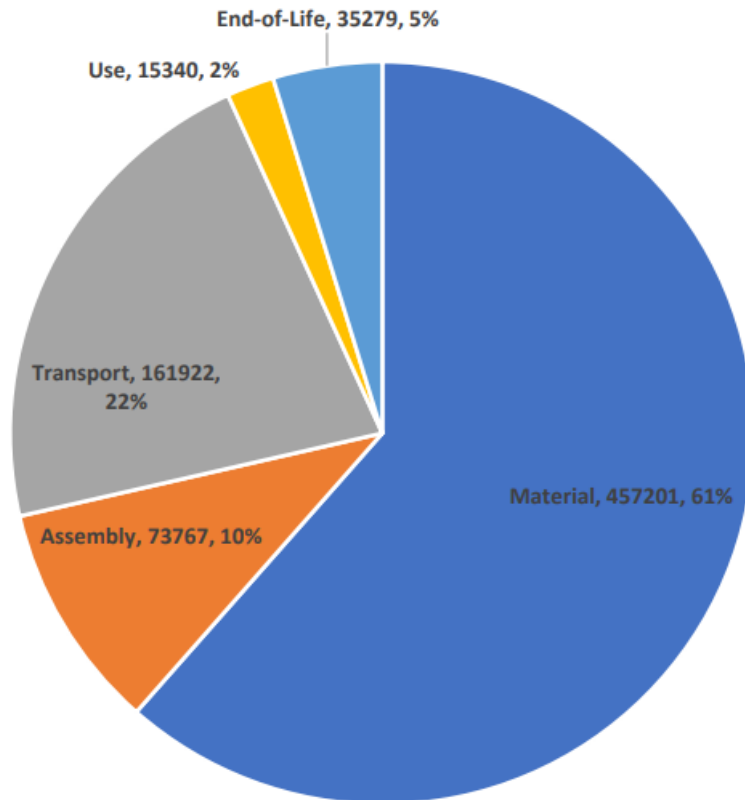


Figure 26: Illustrates GWP per Life cycle impact category

*Raw material extraction and manufacturing:* Steel plate or primary steel contributes the majority of CO<sub>2</sub>e emissions. This is because of primary steel composing the structure of the crane. Asian engineering steel and aluminum sheet are the next highest contributors.

*Transportation:* Transporting the steel plates by truck contributes the most significant amount of CO<sub>2</sub>e emissions. This is because of the significant mass of the steel plates. Secondary contributors are diesel fueling for the trucks and shipping of the crane from Korea to Norway by ship. This is mainly due to amount of fuel required to fuel the trucks and the mass of the crane.

*Crane fabrication and assembly:* The sole dataset for GWP is electricity usage during this phase. Its CO<sub>2</sub>e emissions show that the carbon intensity of the South Korean grid is high enough to contribute the majority of emissions for this crane.

*Use phase:* The sole dataset calculated for GWP is electricity usage during this phase. Its CO<sub>2</sub>e emissions show that the carbon intensity of the Norwegian grid is quite low in comparison to Japan's /Korea's and the crane uses lower amount of electricity during use than assembly.



*End-of-life:* Landfilling is the most significant contributor of CO<sub>2</sub>e emissions. Recycling contributes lower emissions.

Analysis demonstrates that extracting materials from current mining practices produces significant CO<sub>2</sub>e emissions as well as the global transportation of this all-electric crane. Pursuing clean electricity for assembly and use of the crane and ensuring a high percentage of recycling and reuse of the crane materials can improve total GWP.

Switching to cleaner and/or more efficient transport modes could lower the GWP of the crane. Additionally, procuring less carbon-intensive or recycled raw materials could lower the GWP of the crane.

## **5. Discussion**

This chapter discusses the findings analyzed and presented in chapter 4. There is collected data from findings based on expert interviews and literature survey. Those serve as agreements and disagreements between two different data collection approaches.

The discussion of the findings is categorized under the research questions.

### **5.1 The climatic impact of manufacturing companies**

The following specific research questions where the subject of discussion:

**RQ1.1** Which challenges do the current emissions of greenhouse gases (GHGs) represent?

**RQ1.2** To what extent are the emissions of GHGs related to the manufacturing industries?

**RQ1.3** Which motivations could a manufacturing company have for reducing their climatic impact?

**RQ1.4** What are incentives for back shoring?

**RQ1.5** What are challenges/obstacles for back shoring?

This research question aims to find out the reasons why it is important for the manufacturing companies to reduce climate change. The study seeks to determine how manufacturing companies can influence the challenge of climate change and what actions can be undertaken.

As Bill Gates once said about the importance of combating with climate change: “The earth is warming, it’s warming because of human activity, and the impact is bad and will

get much worse. We have every reason to believe that at some point the impact will be catastrophic. Will that point come in 30 years? Fifty years? We don't know precisely. But given how hard the problem will be to solve, even if the worst case is 50 years away, we need to act now." (B. Gates, 2021, How to avoid a climate disaster, *The solutions we have and the breakthroughs we need*)

On the issue of the climatic impact of manufacturing companies there is a focus on reducing emissions and companies are convinced on the value of it in the future from the perspectives of stakeholders such as customers. This confirms the findings from the literature survey.

According to the literature survey, Europe and its strict law to reduce contaminating emissions are opposite to the increasing global emissions due to offshoring and longer supply chains. Managers have been encouraged to think over the implications of their carbon footprints and the social influence of their procurement decisions. Positive impact from an economic point of view isn't necessarily combined with sustainability -social and environmental.

The authors point out that negative environmental impacts and the violation of human rights are the reasons of manufacturers to reconsider the location of productive activities. Additionally, there is a challenge when it comes to manufacturing in Korea and transporting it to for ex Norwegian oil company in terms of cost and environmental sustainability. It is mentioned that the weakness for NOV is that competitors often have European supplier.

In 2016, 196 countries agreed to the common goal known as The Paris Agreement of reducing global warming to 2 degrees compared to the pre-industrial era.

As this commitment was perceived as insufficient the EU came in April 2021 with the purpose to reduce CO2 emissions by at least 55% by 2030 (compared to emissions in 1990). Some years after Paris Agreement companies were forced to set ambitious climate goals.

According to the findings, fabrication in South Korea is highly approved by experts who participated in the interviews. However, it is believed that there would be potentials for the company to enable production in Europe as it has benefits especially in disruption times. Cost is the considerable factor which plays role in choosing location of production activities.

Customers and their buying models are seen as an important key in decision making.

Accordingly- if it is a customer placed in China, he/she would not expect as high-quality

product as f ex Norwegian oil yard. Customer from China would rather prefer the product which has lower cost.

It is believed that if NOV could offer a product to the customer which is proved to contribute to reduction of CO<sub>2</sub>, then customers would be delighted to buy it.

## **5.2 Strategic and operational measures to reduce the climatic impact**

The experts pointed out some measures which may reduce the climatic impact.

These are discussed in this section.

There have been stated few key questions:

**RQ2.1** How could the choice of supplier is affecting the climatic impact?

**RQ2.3** Which new solutions could contribute to decarbonization?

**RQ2.4** To what extent could electrification makes a difference in the reduction of emissions?

### **5.2.1 Decision-makers**

The stakeholders are identified by the researchers as those factors which have capacity to control incentives (subsidizing, CO<sub>2</sub> taxation system, etc.).

According to the role of decision makers implementing back shoring and manufacturing in Europe could have benefits such as creating work locally.

However, there is a challenge since the cost of labor in Europe or Norway is higher than overseas and there is a lack of some experts in house.

### **5.2.2 Fabrication and experience in the field**

Many years' experience and knowledge in the field are identified as a big advantage when it comes to production place. Therefore, experts mentioned that manufacturing in South Korea is still preferred destination.

The experts pointed that for some years ago NOV had manufacturing capacity in Europe and Norway but since downsizing of the organization and the focus on costs South Korea remained as the only one production place.

Additionally, NOV expressed satisfaction from South Korea as manufacturing location.

### **5.2.3 Customers and their expectations**

According to the findings customer and his/her expectations are paramount for the decision concerning production location for NOV.

However, the focus still is on the cost side and since the competition in this market is strong the company focuses on production only in South Korea.

Experts expressed.

### **5.2.4 Resources**

According to the findings if NOV should consider back shoring, then it should evaluate to outsource this job to the third party.

The advantage of back shoring is meaningful especially in the disruption times when delivering of goods is a challenge.

## **5.3 Current climatic footprint of NOV's crane production in South Korea**

The following questions should be answered:

**RQ3.1** What is the use of the electric energy in manufacturing in Korea.

**RQ3.2** Which indirect GHG emissions could be related to electricity production in South Korea

**RQ3.3** Which GHG emissions could be related to the transportation of the crane from Korea to Europe?

To identify the Greenhouse Gas (GHG) footprint of all- electric offshore crane it is used life cycle assessment (LCA).

The aim of this LCA is also to analyze a scenario of relocating manufacturing from South Korea to Europe and to compare the GHG impact of relocating facilities in terms of a cradle-to-grave system boundary.

The life cycle Inventory is based on:

- Calculation sheet
- Bill of materials
- Technical specifications provided by NOV.

Key NOV organizations for this study was NOV Norway and NOV Korea.

Suppliers and companies included:

- Distribution NOW, Siemens, Oswald Elektromotoren GmbH, Shilla Precision and AF Decom

The results claim that the Global Warming Potential impact for the all-electric offshore crane is estimated to 7.44E005 kg CO<sub>2e</sub>.

The biggest contribution to GWP impact category has the raw material extraction and manufacturing phase. It is caused by primarily steel which generates a large GWP impact due to the large quantity of material and their carbon intensity.

Transportation is number two when it comes to the impact to GWP. It is caused by the quantity of product being shipped and distances travelled.

The use phase has the lowest contribution to GWP.

There are potential areas of improvement:

- Renewable energy during assembly
- Use of circular /recycled materials

The Life Cycle Assessment could benefit from improved supplier engagement and data procurement processes by providing more inputs to better analysis model.

## **5.4 The climatic footprints in case NOV's crane production had been moved to Europe**

The following questions should be answered:

**RQ4.1** Which locations could be used as examples in Europe?

**RQ4.2** Which indirect GHG emissions could be related to electricity production in these European countries?

**RQ4.3** Could the GHG emissions from manufacturing and transportation be reduced by moving production to these countries?

Experts were answering that there are plans to implement production in countries such as Poland where production existed before.

The fact is that the time used for transportation the crane from South Korea to Norway could be saved and the customer could get the product earlier in case moving production to Europe.

The findings and the answers of experts prove that the huge benefit considering backshoring has savings in terms of transportation.

There had been conducted analysis by NOV to reflect the comparison between alternative shipping by ship contrary to by boat and the emissions considered.

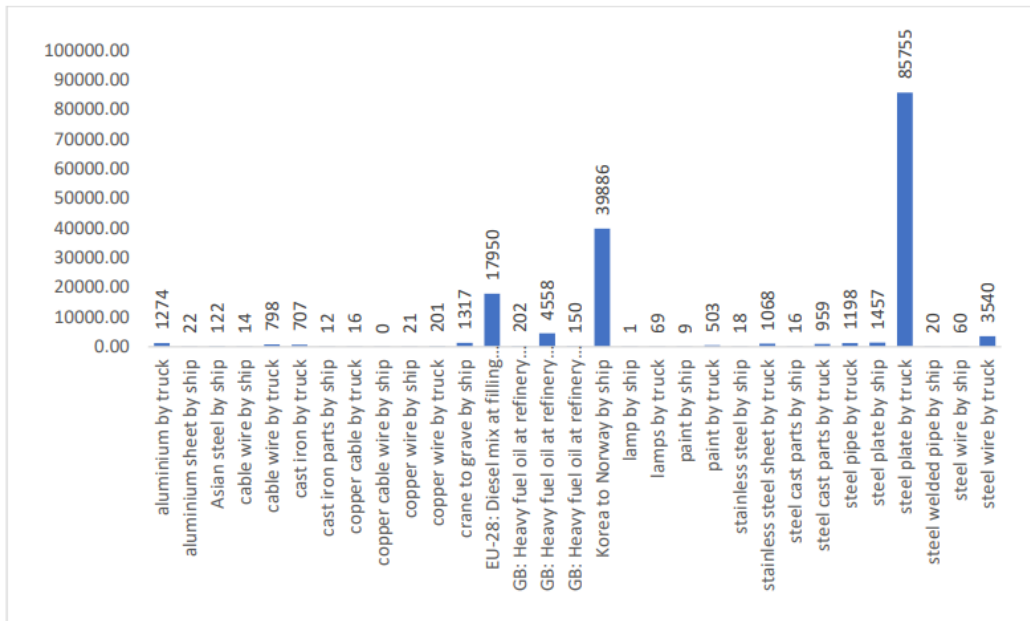


Figure 27: Illustrates GWP and alternative shipping: by ship contrary to by boat (source: NOV presentation )

The data provided by NOV demonstrates that transporting the steel plates by truck contributes to the most significant amounts of CO<sub>2</sub> e emissions. The same amounts are regarding mass of the steel plates.

The second contributors to emissions are diesel for the trucks and shipping the whole crane from Korea to Norway by ship. This is mainly due to significant amount of fuel required to fuel the trucks as well as mass of the entire crane.

Shipping by ship versus truck are also taken into account. Switching to more efficient transport modes could lower GWP of the crane. The same relates to procuring less carbon-intensive or recycled raw materials which could lower the GWP of the crane.

## **5.5 Chapter summary**

Both sourcing strategies- back shoring and offshoring are working but in different ways.

As the experts expressed more willingness to continue production in NOV Korea since the arguments were: knowledge, know each other, many years' experiences etc.

There is no doubt that NOV would satisfy its customers and it is working on solutions that are preferred by the customer. In this way it has chances to stay up with the competition.

## **6. Conclusion**

This chapter includes a summary of the research as well as the conclusion regarding the research objectives and managerial implications of the findings. The chapter also illustrates study's limitations.

### **6.1 Research summary**

The study seeks to uncover whether and in what extent back shoring contributes to sustainability.

The study used a survey method consisting of expert interviews and literature review to acquire perspectives on the research problem of reducing CO2 emissions and other gases by sustainable logistics and back shoring in comparison to earlier trend of offshoring like in my project from South Korea.

The findings of the study show that both sourcing strategies- back shoring and offshoring are working but in a different way and the issue is what the customer expect from the company and how he/she prefer "greener solution" and if he/she is willing to pay higher price for fulfilling it.

The findings of this study could serve as a basis for further research specially for creating scenarios for the climate change as a result of reducing emissions.

### **6.2 Managerial implications**

It is expected that the study will encourage corporate bodies and managers to sustainable development while deciding where to produce the product with respect to the issue of environment.

The study provides insights to policy makers who may implement policies to support back-shoring which also enhance environmental sustainability of manufacturing.

Additionally, the study offers useful insights for managers and suggest them to take into account environmental sustainability when implementing back-shoring decisions.

Finally, the study contributes to the academic debate showing some aspects for future research.

### **6.3 Limitation of the study**

Any research project stands in front of challenges that researcher experience during the study. It doesn't mean that the work is invalid. It is associated with the difficulties during the design process and quality of the data.

There are the following limitations of the study:

First and foremost, there have been some limitations in having primary data. Therefore, some data were generalized.

Secondly, time frame was a major constraint. The timeframe of this study prevented from evaluating additional elements to conduct the project. This study presents a wider scope and would require more time to accomplish it.

Thirdly, the aim of this study was to conduct interviews with more than two experts but since NOV is international company and the time to conduct the research was limited, I ended up with two internal experts and only one external. Additionally, some of the experts were negative to participate in the interview and I had to omit them.

### **6.4 Suggestions for further research**

This section shows the areas that provide prospects for further investigation so researchers can assess the quality of this work. This research seeks to identify the benefits of moving production of the crane to Europe with the respect to environmental benefits. This study aims to provide a comparison analysis of producing in South Korea to Europe instead.

This study could serve as a basis for further research specially for promoting back-shoring.



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# Appendix

## A. Interview guide 1

### Interview guide for the exploratory interviews- Back- shoring and its perspectives

#### Guide for exploratory interviews

(The following information is to be read by the interviewer to the respondent before the core interview starts, and/or shared with the respondent in written form before the interview)

#### >Start recording.

#### The purpose of this interview

This interview is one of the series of interviews with the focus on backshoring and reducing environmental emissions. It will focus on the drivers encouraging to producing in Europe instead of South Korea.

#### Definitions of keywords

- By “back- shoring” we mean the process of returning the production and manufacturing of goods back to the company’s original country
- By “outsourcing” we mean the practice of hiring a party outside a company to perform services and create goods that were traditionally performed inhouse by the company
- Lastly is the term “sustainable environment” which means the ability to maintain an ecological balance in our planet’s natural environment and preserve natural resources for the well-being of present and future generations

## **Procedure and anonymity**

This interview would be recorded in an audio file and a written version would be produced based on this audio file. The transcript would be sent to your e-mail for verification and corrections. After the final version will be agreed between the interviewer and respondent the audio file will be deleted. The transcript will be used as an input and reference for academic publications as well as an attachment to my master's thesis. The transcript will not include information about name of the respondent and the company he/she is working for. However, information about the background of the respondent and the company would be accessible in the transcript and when making references to the interview.

When reviewing the transcript, the respondent should ensure that the respondent and the company are described in an acceptable way.

## **Start of core interview\***

\*In the interview we asked for the contact information of the researcher, this is taken out.

The interviewer states:” This is a semi-structured interview. This means that we have a “checklist” of topics and questions that we want to cover, but also that you as a respondent should feel free to bring any other relevant information to the table at any time.”

## **Structure of interview questions**

The questions have been structured into following categories:

1. Clarification of the expertise and description of the job of the expert
2. General perspective of back-shoring strategy to minimize CO2 emissions.
3. Specific perspective of back-shoring for NOV case
4. Outsourcing as an alternative solution

Under these categories there are main questions and sub questions. The role of the main questions is to find the answer to the key objectives of this interview, but sub questions are helping as a guide and don't need to be followed strictly.

## **Clarification of the expertise and job role of the expert**

- 1) Could you please be so kind and describe your field of work and explain how it is related to the case study?
- 2) Could you please describe your role and your background related to back-shoring?
- 3) Do you take an active part in an aspect of back shoring and environmental sustainability?
- 4) To what extent are you informed about back shoring as a strategy to reduce CO2 emissions?

## **General perspective of back-shoring strategy**

Based on your experience, what is / are your perspectives on choosing back shoring as a sustainable solution which contribute to minimizing CO2 emissions?

5) What are the pros for back shoring your activities?

6) What led the company to reconsider international outsourcing?

7) Which are the main benefits with back-shoring strategy? Is environment a decision factor?

(Do you believe that back shoring could help to reduce emissions (GHG emission)? If answer is yes – please be so kind and explain how?)

8) Which other factors should be considered when addressing the case of back-shoring?

9) Do you think back shoring is contributing to competitive advantage of the company? How?

10) What are the main challenges for implementing back-shoring?

11) How do you think third parties perceive the significance of reducing CO2 emissions and implementing back-shoring for the future?

12) Particularly regarding your supply chain how were they disrupted during the COVID-19 crisis or the war between Ukraine and Russia?

13) What perspectives has back shoring for the future?

## **Specific perspective on back-shoring for NOV**

14) Do you think producing the whole crane in house is the advantage? Why?

15) How do you think back shoring would affect lead time?

16) Do you think NOV possess all that is necessary as human resources, technology, innovation to produce the crane in house instead of abroad?



## **Outsourcing and CO2 emissions**

Different questions were asked which related to production of crane in South Korea

- 17) Could you tell me what was the reasons of outsourcing?
- 18) What activity did you outsource?
- 19) How important were costs in outsourcing?
- 20) Why did you choose South Korea as the place where the crane should be produced?
- 21) Do you experience any challenges while outsourcing such as language barrier, communication, quality, holding control and fulfilling expectations?
- 22) Where there any incurred costs that arose before and after outsourcing?
- 23) How do you think outsourcing impact the environment?

## **B. Interview transcription 1 – Respondent no 1** (Tommy Jacobsen)

Research field/ Research background: Back-shoring, energy, sustainability

Date: 28.03.2023 Duration: 48:30

Interview guide: A – Interview guide 1

--- Start of interview ---

### **Interviewer:**

Hi and thank you for coming.

First and foremost, I would like to ask you about your permission for participating in this interview.

### **Researcher:**

Yes. Yes, that's fine.

### **Interviewer:**

Thank you very much. Since this is the interview on teams it means taken digitally (not personal interview) , I would like to read an explanatory guide. So, the following information is to be read by the interviewer to the respondent before the core interview starts, and/or shared with the respondent in written form before the interview. This interview is one of the series of interviews with the focus on back shoring and reducing environmental emissions. It will focus on the drivers encouraging to producing in Europe instead of South Korea.

Now I would like to explain some definitions used in the interview:

- By “back- shoring” we mean the process of returning the production and manufacturing of goods back to the company’s original country
- By “outsourcing” we mean the practice of hiring a party outside a company to perform services and create goods that were traditionally performed inhouse by the company
- Lastly is the term “sustainable environment” which means the ability to maintain an ecological balance in our planet’s natural environment and preserve natural resources for the well-being of present and future generations

This interview would be recorded in an audio file and a written version would be produced based on this audio file. The transcript would be sent to your e-mail for verification and

corrections. After the final version will be agreed between the interviewer and respondent the audio file will be deleted. The transcript will be used as an input and reference for academic publications as well as an attachment to my master's thesis. The transcript will not include information about name of the respondent and the company he/she is working for. However, information about the background of the respondent and the company would be accessible in the transcript and when making references to the interview.

When reviewing the transcript, the respondent should ensure that the respondent and the company are described in an acceptable way.

Now I would like to firstly find out about your role and how it is related to the case study?

**Researcher:**

My role is a project manager, and I am in the office in Molde for the big company NOV. Obviously we are producing a lot of equipment around the world but for the office in Molde our key product is cranes and those are produced today in Korea. That's the only facility we produce our cranes today.

If we go back 20 years in time, we produced our cranes mainly in Norway.

10 years ago, we had production also in Norway but limited and we had also production in Europe.

A couple of years ago during the downsizing of organization the development of the market ended up with no production facilities in Europe and the only production facility we still have left is Korea. However, NOV branded it as NOV factory so it's our factory and at the time being it's the only factory that we have but still produce the cranes that we are designing in Norway.

Of course, NOV is a big company with a lot of different equipment so the factory in Korea is also producing products for other NOV facilities that I don't even know about because my only thing I think about is cranes.

Obviously, we are doing the production in Korea but some of the cranes that we are selling today is going to be delivered to an oil company in Norway. That's where the challenges start of course considering the environmental footprint and cost of production etc. Many of the competitors have production facilities in Europe.

I need to say it first because many of our projects today is going to be delivered to a shipyard in Korea and it's Singapore or maybe somewhere like there and for those projects it's not a problem to produce a crane in Korea. We are still highly focused on the market in Norway, but the North Sea is of course very big and important part that we deliver to.

I think the study you are doing is mainly related to where we have a delivery to the customer in Norway. If the customer wants the crane to be delivered to Korea obviously, we will not produce it in Europe.

So now we are talking about the scenario where we in Norway has sold a crane for a Norwegian customer. We are designing it in Norway, we are doing all the administrative work in Norway divided by Kristiansand and Molde but 99% of administrative work with design and engineering work, project management -that's all from Norway.

My role is to ensure that when we have the contract for the crane it's my job to take it from the sales team and deliver the crane to customer on time and to the correct price of course. The price is fixed for the crane costs.

So, if we have a project with two cranes still would be two cranes for some risk. It's almost never one crane. It is often two or more cranes for a project. Such is in this case study was its Jotun that was the reference.

My job is to ensure that those two cranes are delivered to the delivery address which in this project was Stavanger. I need to ensure that delivery date is met and that we have done it according to the budget that we have added to this.

So, this is easy summary of my job.

**Interviewer:**

Thank you so much Tommy. Now I see about your role in NOV.

Let me ask you some questions about climatic sustainable and how your role is connected to it?

**Researcher:**

Yes. I could say that it's not a specific description to my role to ensure that the project meets certain climatic criteria.

It's boring answer but obviously considering we are the part of the company- NOV it's to all our responsibility to ensure that we follow certain criteria but I find it quite challenging because obviously this discussion now building a crane in Korea with parts shipped from Europe but shipping the crane back again I am not feeling any direct situation to change it because our supplier is in Europe -that's the pattern of our design and our design is prompt suppliers in Europe. We use sub stab suppliers specific deliver suppliers, and we need to

use them, and we are building the crane in Korea. I cannot start a new factory of course but obviously have you been trying me to be aware and affect this situation of course.

Yes- I have a possibility to affect how we are doing things but for the project we need to deliver what the Sales have been promising to the customer and for the Jotun project it was already included in the contract that we were going to build the crane in Korea and ship it back to Norway. Then it's kind of impossible to make any changes to this specific project.

**Interviewer:**

Thank you so much Tommy. Really good answer with so much information for me to mention in my master thesis.

The next questions I would like to ask you would be related to back-shoring. Could you please tell me how you perceive back-shoring as a sourcing strategy and its pros and cons?

**Researcher:**

I have been working for NOV 20 years so for me the challenge is that I don't have so much background of how it could have been because all I know about this is that we have always done like this but obviously if we in the future find a facility in Europe that would build cranes for us that would be something that we would need to outsource and I don't think it's a goal for us to buy a facility in Europe to do it. We would probably be going to outsourcing to a European facility to build something. So if immediately for me as a project manager I think I would say that if it was for me to choose if I would prefer to use NOV Korea or outsource building in an external company in Europe regardless of shipping cost etc I would definitely choose the Korean factory because it's my colleagues I know them and its of course much more convenient for me to have a known factory which have built the cranes several times before and they know what they need to do with the shipment and the drawing and some months later (six months later) it's a finished product. But of course I am aware that in the future we would have (and it would be hard to avoid it) a European alternative of building the cranes but in my mind I am quite sure that it would be an external company that we would outsource the building to that and I am confident to say that it will cost a lot of more work for the project manager because it's not just following the normal process of doing this. It means that we would need to have an external company to do things for us and it will always be a struggle to have built what we have agreed on to the price we have agreed because using things internally it's never a discussion about cost.

Discussions about cost is easier to have internally because it's with your colleagues and within the company.

The company that builds the same cranes several times they probably must do it more efficient than a new company.

That's of course the overall cost picture considering the cost that we are paying to for shipping something back and from Korea -is easy for project manager to also see that considering the cost a European facility building the cranes would be better efficient than the cost. But I think it's a lot more hassle for the project manager. That's of course something I need to deal with.

**Interviewer:**

Thank you for your answer, Tommy.

Additionally, could you say that back-shoring is a good alternative in disruptions times with long lead time?

**Researcher:**

Yes, I would agree on that because it's some projects with a lot of need regarding delivery time and of course it's much easier to do a priority internally with the company which is our colleagues, and we could discuss.

Many of our suppliers that we have as reliable for this period now they need to be kind to all their customers. It's not like that that we are always on the top of the priority list for big suppliers with Europe like Siemens or Bosch Electro etc . We like to consider ourselves as a very big and important customer but for the companies like Siemens they have a lot of customers that are much bigger than NOV.

When we try to push them and say that this is important to have, and we need to have this tomorrow they will of course politely say that yes, they understand and do whatever they can, but I get the feeling that it is impossible.

Having the back-sourcing than to do it ourselves it's of course easier to prioritize what's important project for ourselves.

If we today had a European facility that are building some of the cranes that we are going to deliver now I think the delivery situation could be much more challenging if we were building the crane in Europe with the external company instead of the situation that we just manage to handle in our company in Korea. It's our colleagues and we can find solutions together with them.

**Interviewer:**

Thank you for your answer, Tommy.

Now let me ask you about your opinion about outsourcing as another sourcing strategy.

Could you please tell me how you perceive outsourcing comparing to back-shoring? One of the challenges mentioned in literature is language barrier – had you ever experienced such problems?

**Researcher:**

I had never experienced any language problems with my colleagues in South Korea.

Moreover, if you ask a Norwegian customer, he will of course prefer to have the crane built in Norway. Most might be in Bergen or so but that's not an alternative.

I think we never would see our products are to be produced in Norway again so I think if we could choose between producing in Europe or in Korea I think someone could say that it is efficient to produce it in Europe but than its back to the transport cost to have it back to Norway so obviously that would be preferred one but there are no opinions from the customers about producing in Korea.

People from Korea with who we are dealing with are speaking perfectly English at the project level and when it comes to the customers, they had been very satisfied with the product that had been built in Korea.

**Interviewer:**

How do you think third parties ( f ex customers) perceive the significance of reducing CO2 emissions and implementing back-shoring for the future?

**Researcher:**

I am not into those discussions with the customers directly and I am fully aware that our Sales team are preferring those kinds of situations where environmental footprint is even as important for the customer as the price.

Going back 20 years ago or 10 years back or 5 years back the only thing that mattered was price – price and quality. When it comes to quality, they would have to get high quality from NOV. We are aware of the fact that our price is not low but the reputation of NOV is high -we are delivering top product for its price.

In the future I am quite sure that deciding a supplier will more and more be demanding and the supplier that could give us good, green environmental footprint.

That is already a discussion with the customers but not from my level but rather from the sales team because now my job starts the contract decides. It's the process prior deciding the contract.

It might be that at a certain level we would end up losing the contract because we don't have good enough environmental footprint of the factory building the crane in Korea comparing the competitors that will build a crane in Europe.

**Interviewer:**

Are customers expecting documentation of environmental footprints?

**Researcher:**

At the project level I have no project that this is a requirement.

I think from the management level or sales perspectives I am quite sure that they need to fill some kind of documentation.

I have a feeling that today it is not a requirement, but the customer is asking for it for some kind of information or at least to check if we have considered it.

I don't think that today we have a strict requirement to it and I don't think we are able to do it either but we are working on it now.

Considering the values that I was asking my colleagues to get to you if we were in a position to give that immediately it would be easier for me to say that we have control of them but considering the fact that I need to check it I don't think we have it.

**Interviewer:**

The last part of the interview considers outsourcing as an alternative sourcing strategy. Is this a good strategy for NOV?

**Researcher:**

Having in mind that what we are doing now in Korea I would not call an outsourcing because we own the factory in Korea.

At the start that we used this factory in Korea it was not a NOV factory. We outsourced it because of cost. I can confirm that my opinion was also that it is only due to cost.

Obviously, we observed more and more products delivering in Korea. Its two sides of it. Many years ago we needed a facility in Korea to deliver cranes in Korea but we needed to go from three or two facilities down to one. I think Korea was chosen because of cost.



At a certain point we ended up buying a production facility in Korea so that's the reason why I would say that the Korea production today is not outsourcing because of its NOV factory.

However, it started as outsourcing alternative because at that time we had NOV factory in Norway producing the cranes (20years ago).

NOV had been a big company for many years, with a many good projects 10 years ago so given the opportunity to buy a Korean company to build for us. Of course, it's not the case for all suppliers but for NOV at certain point it was necessary to buy a factory in order to production line etc.

**Interviewer:**

Thank you so much. I got so much relevant information. You covered so many questions. I am thankful for the help and the interview.

**Researcher:** Thank you that you wanted to interview me.

--- End of interview ---

## **C. Interview guide 2**

### **Interview guide for the exploratory interviews- Back- shoring and its perspectives**

#### **Guide for exploratory interviews**

(The following information is to be read by the interviewer to the respondent before the core interview starts, and/or shared with the respondent in written form before the interview)

#### **>Start recording.**

#### **The purpose of this interview**

This interview is one of the series of interviews with the focus on backshoring and reducing environmental emissions. It will focus on the drivers encouraging to producing in Europe instead of South Korea.

#### **Definitions of keywords**

- By “back- shoring” we mean the process of returning the production and manufacturing of goods back to the company’s original country
- By “outsourcing” we mean the practice of hiring a party outside a company to perform services and create goods that were traditionally performed inhouse by the company
- Lastly is the term “sustainable environment” which means the ability to maintain an ecological balance in our planet’s natural environment and preserve natural resources for the well-being of present and future generations

## **Procedure and anonymity**

This interview would be recorded in an audio file and a written version would be produced based on this audio file. The transcript would be sent to your e-mail for verification and corrections. After the final version will be agreed between the interviewer and respondent the audio file will be deleted. The transcript will be used as an input and reference for academic publications as well as an attachment to my master's thesis. The transcript will not include information about name of the respondent and the company he/she is working for. However, information about the background of the respondent and the company would be accessible in the transcript and when making references to the interview.

When reviewing the transcript the respondent should ensure that the respondent and the company are described in an acceptable way.

## **Start of core interview\***

\*In the interview we asked for the contact information of the researcher, this is taken out.

The interviewer states:” This is a semi-structured interview. This means that we have a “checklist” of topics and questions that we want to cover, but also that you as a respondent should feel free to bring any other relevant information to the table at any time.”

## **Structure of interview questions**

The questions have been structured into following categories:

1. Clarification of the expertise and description of the job of the expert
2. General perspective of back-shoring strategy to minimize CO2 emissions.
3. Specific perspective of back-shoring for NOV case
4. Outsourcing as an alternative solution

Under these categories there are main questions and sub questions. The role of the main questions is to find the answer to the key objectives of this interview, but sub questions are helping as a guide and don't need to be followed strictly.

## **Clarification of the expertise and job role of the expert**

1. Could you please be so kind and describe your field of work and explain how it is related to the case study?
2. Could you please describe your role and your background related to back-shoring?
3. Do you take an active part in an aspect of back shoring and environmental sustainability?
4. To what extent are you informed about back shoring as a strategy to reduce CO2 emissions?

## **General perspective of back-shoring strategy**

Based on your experience, what is / are your perspectives on choosing back shoring as a sustainable solution which contribute to minimizing CO2 emissions?

- 5) What are the pros for back shoring your activities?
- 6) What led the company to reconsider international outsourcing?
- 7) Which are the main benefits with back-shoring strategy? Is environment a decision factor?  
(Do you believe that back shoring could help to reduce emissions (GHG emission)? If answer is yes – please be so kind and explain how?)
- 8) Which other factors should be considered when addressing the case of back-shoring?
- 9) Do you think back shoring is contributing to competitive advantage of the company? How?
- 10) What are the main challenges for implementing back-shoring?
- 11) How do you think third parties perceive the significance of reducing CO2 emissions and implementing back-shoring for the future?
- 12) Particularly regarding your supply chain how were they disrupted during the COVID-19 crisis or the war between Ukraine and Russia?
- 13) What perspectives has back shoring for the future?

## **Specific perspective on back-shoring for NOV**

- 14) Do you think producing the whole crane in house is the advantage? Why?
- 15) How do you think back shoring would affect lead time?

16) Do you think NOV possess all that is necessary as human resources, technology, innovation to produce the crane in house instead of abroad

### **Outsourcing and CO2 emissions**

Different questions were asked which related to production of crane in South Korea

17) Could you tell me what was the reasons of outsourcing?

18) What activity did you outsource?

19) How important were costs in outsourcing?

20) Why did you choose South Korea as the place where the crane should be produced ?

21) Do you experience any challenges while outsourcing such as language barrier, communication, quality, holding control and fulfilling expectations?

22) Where there any incurred costs that arose before and after outsourcing?

23) How do you think outsourcing impact the environment?

## **D. Interview transcription 2 – Respondent no 2**

(Terje Korsnes)

Research field/ Research background: Back-shoring, energy, sustainability

Date: 29.03.2022

Duration: 48:18 Interview guide: C. Interview guide 2

--- Start of interview ---

### **Interviewer:**

Hi and thank you for coming.

First and foremost, I would like to ask you about your permission for participating in this interview.

### **Researcher:**

Yes. Yes, that's fine.

### **Interviewer:**

Thank you very much. Since this is the interview on teams it means taken digitally (not personal interview) , I would like to read an explanatory guide. So, the following information is to be read by the interviewer to the respondent before the core interview starts, and/or shared with the respondent in written form before the interview. This interview is one of the series of interviews with the focus on back shoring and reducing environmental emissions. It will focus on the drivers encouraging to producing in Europe instead of South Korea.

Now I would like to explain some definitions used in the interview:

- By “back- shoring” we mean the process of returning the production and manufacturing of goods back to the company’s original country
- By “outsourcing” we mean the practice of hiring a party outside a company to perform services and create goods that were traditionally performed inhouse by the company
- Lastly is the term “sustainable environment” which means the ability to maintain an ecological balance in our planet’s natural environment and preserve natural resources for the well-being of present and future generations

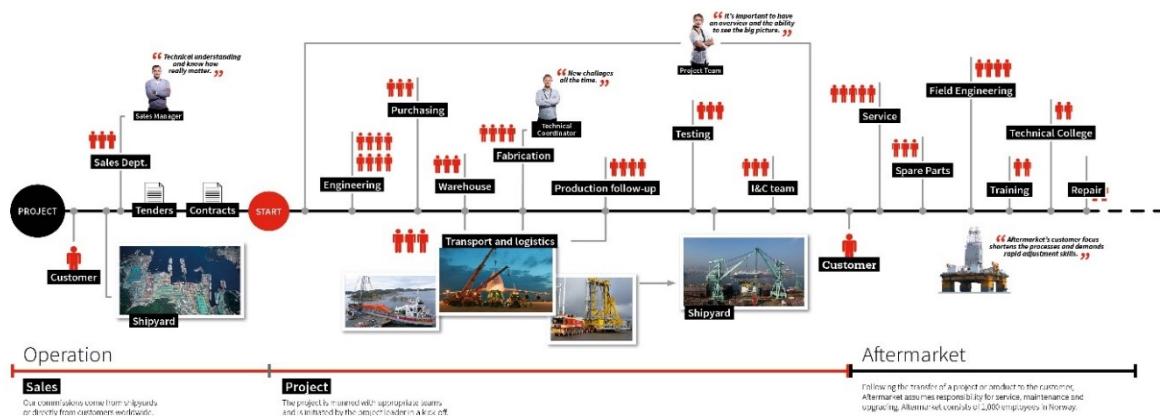
This interview would be recorded in an audio file and a written version would be produced based on this audio file. The transcript would be sent to your e-mail for verification and corrections. After the final version will be agreed between the interviewer and respondent the audio file will be deleted. The transcript will be used as an input and reference for academic publications as well as an attachment to my master's thesis. The transcript will not include information about name of the respondent and the company he/she is working for. However, information about the background of the respondent and the company would be accessible in the transcript and when making references to the interview.

When reviewing the transcript, the respondent should ensure that the respondent and the company are described in an acceptable way.

Now I would like to firstly find out about your role in NOV and how it is related to the case study?

**Researcher:**

I am local director. In short, I could say if you take a look on the picture of the NOV Norway Process Chain below:



As we see from the picture above the process chain is divided into three stages: its Sales, its project, and its aftermarket.

Every project we have starts with a dialog with the customer and that's taken care by Sales and ends up in a contract.

The contract says what we had agreed with the customer, it has commercial terms and what the machine is going to be used for, it has a technical clarification and so on.

When the contract with the customer is signed it is handed over to project and here is where my role and responsibility starts.

For all the contract we have in NOV the contract is my responsibility and that is to follow up and to ensure that it is delivered accordingly.

We have purchasing with components and which we are buying all over the world: from Norway, from Europe, from Australia and so on and then it is transported into the warehouse -today we are only produce manufacture crane in Korea.

So, I have a dialogue with Korea to ensure that a quality and the timeline and other conditions are followed and then we deliver the cranes to the customer according to the agreed terms in the contract. It could be that we deliver it as we say: Ex work in Korea with the customer who is picking it up or for Jotun where we also have the isolation of the crane of the specific vessel.

So, my job is to take care of all the projects including the risks and the measures of the portfolio to foresee that we deliver according to the contract to the customer.

**Interviewer:**

Thank you so much for the answer.

Now could you please be so kind and how your role related to climatic sustainability-case study?

**Researcher:**

It is a very good issue because when we start a project that actual project is already given. But a lot of cranes that we are delivering are supposed to be installed in a yard either in Singapore or China or somewhere in Asia.

We see that there are more and more cranes coming into Europe for instance Jotun or cranes like that.

We also see that the construction market which it's for instance Solstad and so on which are by the Norwegian coast moved to Norway.

Then for the big picture building cranes in Asia and sending them by boat all the way to Norway that's not a very green way to do it.

Therefore, we see that we need a fabrication facility in Europe, so we don't have to send all those cranes all the round the world.

I am working to facilitate it together with supply chain within NOV – that's one thing.



We also are buying things in smaller amounts and smaller parts like gears from Germany and those we often see are sent by the airfreight to Korea. There are many reasons for that. That's the project responsibility to push on engineering so that those gears if we could use them as an example can be released and bought and the purchase could happen earlier so that we could send them /transport them by sea which is cheaper and more sustainable when it comes to footprint emissions.

Considering the data that Ronny had sent to you -you will discover that even though we are delivering a crane in Asia you would see production facilities which have very high environmental footprints because steel production is based on coal( electricity) – so we have to go further back in our value chain so we are going to deliver the crane in Europe, it makes no sense to buy the steel from Korea. Then we have to find a vendor in Europe and I think that we will meet the same issues if we are going to buy steel in Europe as well as because coal is the primary source of electricity in big parts of Europe.

**Interviewer:**

Thank you so much for so deep description of your role and the climate sustainability case. Now I would proceed and ask you more about sourcing strategies.

First could you please tell me what is your perspective of back-shoring for NOV? Maybe you could say a little about advantages and disadvantages of back shoring for NOV?

**Researcher:**

I can start with the challenges. As most of the industry especially oil and gas industry are very much driven by cost. To have a success in implementing off-shore fabrication which have a lower footprint -it's very much up to the customer. Ok?

If our customer is a Yard in China, they don't care about the environment.

You can imagine it's a big yard with mainly Chinese employees and as I see it focusing on greener environment is also a matter of living standards. Do you agree?

In Norway living standards are quite high so we can afford to those kinds of choices.

If you live off-shore east in China -you really don't care because you have so many other problems to deal with first.

So, if our customer is a yard in China then everything is about cost. On the other side if our customer is a Norwegian oil company which is on the other end of the scale we can use as an illustration Equinor which has a very good sense of responsibility, so we have to start with those customers that see the value in making a lower environmental footprint.

Then we must tell them – let me say that we assume firstly that we have two fabrication concepts. We can say that if you are using concept A then the cost is some and we can have environmental footprint on this machine of a number and then we can compare it and say ok concept B is having 10% higher cost, but we save the environment since it has lower environmental emissions.

Then the next step would be that the customer chooses which one he wants. We must be able to have a consumer that get the cost of the crane f ex 5 mill dollars with the CO2 emissions.

However, the consumer can prefer an alternative of smaller emissions at a higher cost. We must be able to listen to the consumer. That's the dilemma because often and that's also with Jotun case the consumer is not always an end user since its often a yard. A crane is a small piece on a bigger vessel. That's a challenge.

If the consumer is a yard in China, they will always go for the lower price.

**Interviewer:**

Thank you Terje.

Do you agree that back-shoring can give competitive advantage for NOV? How?

**Researcher:**

Yes of course because today the freight of the crane from Korea to Europe probably is at the cost of 1 million dollar. We have the consumer saying that we have competitors but produce crane in Europe then if everything else is equal then they will be able to send the crane cheaper than us. But we also know that most of the consumers if we are talking about consumption market so day in east banks of China use most of the projects.

We know that in the future banks will offer cheaper loans if they would provide good vessel. We can have consumer and offer European made crane with lower CO2 emissions and helping the customer saying: ok this is a crane with a lower footprint than another crane.

**Interviewer:**

Thank you.

Additionally, are customers asking about documentation for climatic sustainability of NOV?

**Researcher:**

No – very little expectations from the customers. I don't think that industry has made it ready yet so that's one of the things we are discussing and has started working on.

If the industry could set a standard and provide those answers to the customers before they even, ask about it -that would give us advantage (comparing our competitors).

However, it is hardly ever asked.

**Interviewer:**

Do you perceive back-shoring as an good solution in face of disruptions such as political affairs (war), COVID 19 and so on?

**Researcher:**

Disruptions – such as COVID 19, and the political war between Ukraine and Russia were affecting the lead time and the whole industry has experienced it.

It's especially on electro components but we also see that the cost is higher because of the disruptions. Everything is getting more expensive.

**Interviewer:**

Thank you. Could you tell me if we could use back-shoring for the case of Jotun?

**Researcher:**

NOV Korea it's a part of our company and its our colleagues. If we are going to produce a crane in Europe than we need a third party. (vendor)

I think if we had a customer today and say that: ok we are going to buy a crane from you, but it has to be produced in Europe then we would been able to do it today.

The fact is that we don't have any cranes in production in Europe today.

However, we are collaborating with Gafaco in Gdansk area, and we know that they have all facilities that are required, and they are a good vendor so we could have done it.

Anyway, we are not doing it, but it is possible.

It is not many years since we produced cranes in Europe so we can do it again- I am sure.

**Interviewer:**

Now could you please tell me about back-shoring-what is pros and cons contrary to choosing outsourcing?

**Researcher:**

I don't prefer the one above the other sourcing alternative because its different.

There are pros and cons of both alternatives, but you need to work different to own fabrication side than to third party vendor.

It's just different and I need to say that both are working very well and as long as we can deliver cranes at an agreed cost with certain quality on time.

**Interviewer:**

Thank you. At last, I would like you to tell me what do you think are challenges for using outsourcing which had been used for many years ago also in the case of NOV?

**Researcher:**

South Korea is our own company back to 2008 its 15 years ago but I have been to yard where our equipment is installed on a vessel in China and of course you see things that you don't want to see.

That's on the yards that are maybe our customers.

So of course, in China I saw things that are not of our standards. (Things that don't cover our high standards)

**Interviewer:**

Thank you so much Terje for participating in the interview and give me so much of significant information.

**Researcher:**

Yes, and the same for you.

--- End of interview ---

## **E. Interview guide 3**

### **Interview guide for the exploratory interviews- Back- shoring and its perspectives**

#### **Guide for exploratory interviews**

(The following information is to be read by the interviewer to the respondent before the core interview starts, and/or shared with the respondent in written form before the interview)

#### **>Start recording.**

#### **The purpose of this interview**

This interview is one of the series of interviews with the focus on backshoring and reducing environmental emissions. It will focus on the drivers encouraging to producing in Europe instead of South Korea.

#### **Definitions of keywords**

- By “back- shoring” we mean the process of returning the production and manufacturing of goods back to the company’s original country
- By “outsourcing” we mean the practice of hiring a party outside a company to perform services and create goods that were traditionally performed inhouse by the company
- Lastly is the term “sustainable environment” which means the ability to maintain an ecological balance in our planet’s natural environment and preserve natural resources for the well-being of present and future generations

#### **Procedure and anonymity**

This interview would be recorded in an audio file and a written version would be produced based on this audio file. The transcript would be sent to your e-mail for verification and corrections. After the final version will be agreed between the interviewer and respondent the audio file will be deleted. The transcript will be used as an input and reference for academic publications as well as an attachment to my master's thesis. The transcript will not include information about name of the respondent and the company he/she is working for. However, information about the background of the respondent and the company would be accessible in the transcript and when making references to the interview.

When reviewing the transcript the respondent should ensure that the respondent and the company are described in an acceptable way.

### **Start of core interview\***

\*In the interview we asked for the contact information of the researcher, this is taken out.

The interviewer states:” This is a semi-structured interview. This means that we have a “checklist” of topics and questions that we want to cover, but also that you as a respondent should feel free to bring any other relevant information to the table at any time.”

### **Structure of interview questions**

The questions have been structured into following categories:

1. Clarification of the expertise and description of the job of the expert
2. General perspective of back-shoring strategy to minimize CO2 emissions.
3. Specific perspective of back-shoring for NOV case
4. Outsourcing as an alternative solution

Under these categories there are main questions and sub questions. The role of the main questions is to find the answer to the key objectives of this interview, but sub questions are helping as a guide and don't need to be followed strictly.

### **Clarification of the expertise and job role of the expert**

1. Could you please be so kind and describe your field of work and explain how it is related to the case study?

2. Could you please describe your role and your background related to back-shoring?

3. Do you take an active part in an aspect of back shoring and environmental sustainability?

4. To what extent are you informed about back shoring as a strategy to reduce CO2 emissions?

### **General perspective of back-shoring strategy**

Based on your experience, what is / are your perspectives on choosing back shoring as a sustainable solution which contribute to minimizing CO2 emissions?

5) What are the pros for back shoring your activities?

6) What led the company to reconsider international outsourcing?

7) Which are the main benefits with back-shoring strategy? Is environment a decision factor?

(Do you believe that back shoring could help to reduce emissions (GHG emission)? If answer is yes – please be so kind and explain how?)

8) Which other factors should be considered when addressing the case of back-shoring?

9) Do you think back shoring is contributing to competitive advantage of the company? How?

10) What are the main challenges for implementing back-shoring?

11) How do you think third parties perceive the significance of reducing CO2 emissions and implementing back-shoring for the future?

12) Particularly regarding your supply chain how were they disrupted during the COVID-19 crisis or the war between Ukraine and Russia?

13) What perspectives has back shoring for the future?

### **Specific perspective on back-shoring for NOV**

14) Do you think producing the whole crane in house is the advantage? Why?

15) How do you think back shoring would affect lead time?

16) Do you think NOV possess all that is necessary as human resources, technology, innovation to produce the crane in house instead of abroad?

## **Outsourcing and CO2 emissions**

Different questions were asked which related to production of crane in South Korea

- 18) Could you tell me what was the reasons of outsourcing?
- 19) What activity did you outsource?
- 20) How important were costs in outsourcing?
- 21) Why did you choose South Korea as the place where the crane should be produced ?
- 22) Do you experience any challenges while outsourcing such as language barrier, communication, quality, holding control and fulfilling expectations?
- 23) Where there any incurred costs that arose before and after outsourcing?
- 24) How do you think outsourcing impact the environment?



## **F. Interview transcription 3 – Respondent no 3** (Ronny)

Research field/ Research background: Back-shoring, energy, sustainability

Date: 31.03.2023 Duration: 33:54 Interview guide: E. Interview guide 3

--- Start of interview ---

### **Interviewer:**

Hi and thank you for coming.

First and foremost, I would like to ask you about your permission for participating in this interview.

### **Researcher:**

Yes. Yes, that's fine.

### **Interviewer:**

Thank you very much. Since this is the interview on teams it means taken digitally (not personal interview) , I would like to read an explanatory guide. So, the following information is to be read by the interviewer to the respondent before the core interview starts, and/or shared with the respondent in written form before the interview. This interview is one of the series of interviews with the focus on back shoring and reducing environmental emissions. It will focus on the drivers encouraging to producing in Europe instead of South Korea.

Now I would like to explain some definitions used in the interview:

- By “back- shoring” we mean the process of returning the production and manufacturing of goods back to the company’s original country
- By “outsourcing” we mean the practice of hiring a party outside a company to perform services and create goods that were traditionally performed inhouse by the company
- Lastly is the term “sustainable environment” which means the ability to maintain an ecological balance in our planet’s natural environment and preserve natural resources for the well-being of present and future generations.

This interview would be recorded in an audio file and a written version would be produced based on this audio file. The transcript would be sent to your e-mail for verification and corrections. After the final version will be agreed between the interviewer and respondent the audio file will be deleted. The transcript will be used as an input and reference for academic publications as well as an attachment to my master's thesis. The transcript will not include information about name of the respondent and the company he/she is working for. However, information about the background of the respondent and the company would be accessible in the transcript and when making references to the interview.

When reviewing the transcript, the respondent should ensure that the respondent and the company are described in an acceptable way.

Now I would like to firstly find out about your role and how it is related to the case study?

**Researcher:**

I would tell a little about my background. Its 20 years ago since I got master's degree in retired physics where I specialized on renewable energy sources. Since then, I have worked as a architect, engineer and was hired by the NOV as a equip manager for structural calculations (nearly 10 years ago).

For 4 or 5 years I have worked as a manager where my role is product development and business development for the most part. In that role we are seeing that our customers are more and more preoccupied by CO2 footprints of not just an equipment but entire operations.

So that actually means that we need to take it into account.

It is also related to the product life cycle assessment report that you printed.

We need a starting point of where we are today. Figuring out which main contributors are when it comes to footprints so that we can informedly do something about these significant contributors.

**Interviewer:**

Thank you so much for the description of you field of work in NOV.

Could you now tell me if you and the company take active role for climatic sustainability?

**Researcher:** Thank you for your answer. Let me ask you about how you perceive back-shoring as a sustainable solution for minimizing CO2 emissions?

**Interviewer:**

Start from the point of why we are doing outsourcing? why we are doing overseas in another countries?

When it comes to the main motivations it is of course -cost. The labor costs in these countries is much lower and so the total costs of running the project becomes lower even including transportation costs.

Now that may indicate that transportation have been too cheap -that any emissions incurred by transportation has not been properly calculated before in terms of costs and environmental sense.

So, if we are talking about bringing these kinds of projects back to for instance Norway or at least immediate areas we would be doing so because we would reduce cost for transportation,

reduce emissions from transportations, we will have political incentives for bringing work back to Norway so there are all positives.

There are also negatives such as lack of labor force and also these relative high costs for labor.

There were some of the offsets by at least of a perception that the quality and service of our labor can be faster and with a higher quality but also hard to quantify the documents and then we see added complexity for our part that's obliged.

Fabrication location could be relevant here in Norway that are not suitable at all.

**Interviewer:**

Thank you.

However, do you think choosing back shoring strategy for NOV would give competitive advantage?

**Researcher:**

No- not at that stage. I don't think so.

The reason for that is that when it comes to transportation it's too cheap.

If we would say that transportation contract could pay a certain CO2 tax for everything that is transported, I think we would see quite different grades of bringing the contract back to our work.

**Interviewer:**

Ok -I see. Do you think NOV as a company is ready for implementing back-shoring?

**Researcher:**

That was the point that I was touching when it comes to facilities, fabrication perspectives and so on. We have done a lot of research into that. There are fabrications in Poland, Lithuania and even in Norway. In Norway we have a couple of them where we could bring up to be fully functioning fabrications.

However even if we are already as a supplier what is even more important is that our customers are willing and ready to see the benefits from their perspectives and be willing to join us on the journey to take extra perceived costs, so it depends also on how their value these reductions of CO2 emissions for instance.

**Interviewer:**

Ok. Now what are your general and specific perspectives of back-shoring?

**Researcher:**

We have had the model until 2014 when we fabricated for instance from Poland and shipped to Norway and back but there is a reason why it stopped and again it is due to costs. It's a market that has a fairly strong competition. So, if we unable to meet more or less our competitors' level of price tag and we offer more expensive products and the customer value the quality and product execution model that we can bring to the table but still cost is an important factor.

**Interviewer:**

Thank you.

Next strategy is outsourcing- how you perceive this strategy?

**Researcher:**

As for today we are not outsourcing because Korea facility is NOV company. We are doing insourcing to Korea.

But geographically speaking if it would be producing overseas the benefits is simply that we can make sure that that facility is filled is filled with projects at any time -they are not running out of jobs meaning that facility is never idle.

Idle facility is very expensive-that is a problem.

But they are downsizing because we have engineers who design the crane -the system, framework, control system -they are too seldom perhaps able to see the crane in distance

and for crane purposes we need new talent to organizations and learning them about the crane. There is an office in Norway and the actual crane is building in Korea.

It makes more challenges in groups to work together.

It is benefits as well as some drawbacks.

**Interviewer:** Thank you-I see. But do you see some big problems with using outsourcing as a sourcing strategy?

**Researcher:**

It is a language barrier, but it diminishes over time and having worked for some time.

Initially the barrier was higher.

It is communication at certain level. If you have engineers talking to each other can be more challenging than speaking to your neighbor in the office.

It is also the challenge about the control level. You need to how the think and respond.

I understand what my colleagues are saying but my opinion is that communication is not as ideal as it could be.

**Interviewer:**

Thank you so much for participating in my interview Ronny.

**Researcher:**

Thank you

--- End of interview ---