Master's degree thesis

LOG950 Logistics

Barriers towards implementation of a sharing platform: A multiple Case Study from the Norwegian Oil and Gas Industry

Henning Liseth Langedal

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Preface

The current lack of sustainability, and the extensive use of resources the modern world represents, are perhaps the biggest challenges of our time. Thus, it has been motivating to write about something that address these concerns, and which in my opinion can contribute to solve them, or at least pulls in the right direction.

I would like to thank my supervisor for guiding me in the research process and for providing me valuable feedback throughout the semester. In addition, I want to thank CCB Subsea in particular, together with the other case companies. By willingly sharing their experiences and providing me information, they have made it possible to write a thesis on the subject.

Abstract

Circular economy is gaining traction as a scientific term, and as an economic system capable of addressing the challenges associated with limited natural resources and modern consumption patterns. Despite this, the prevalence of circular business models is still limited, they involve barriers, and the overweight of scholars emphasizes closing of material loops rather than slowing them. In addition, there is a lack of research on industry-specific barriers, and on specific circular business models. Based on that, this thesis aims at uncovering incentives and barriers towards a sharing platform in the Norwegian Oil and Gas industry, followed by means to overcome them and realize the potential of a circular economy.

This is a multiple case study, using a qualitative approach by interviewing six organisations, whereby four are exploration and production companies, one is the developer of the sharing platform, and the last one is the industry association who owns and run the sharing platform. The sharing platform fulfils the characteristics of a circular business model, slows the material loops, and extends the product life cycles through repair, reuse, and refurbishment. The incentives are mainly economic, but also environmental and related to increased preparedness. Multiple barriers are uncovered. They include barriers found in literature, like documentation and regulations, change resistance, and competing solutions. In addition, industry-specific barriers are uncovered, mainly related to risk mitigation due to better preparedness, and standardisation barriers due to the challenging and shifting environments the organisations operate in. The results can be applicable in similar industries abroad, and in the further development of the sharing platform in this industry.

List of Acronyms

CE – Circular Economy

O&G – Oil and Gas

CBM – Circular Business Model

CBMI – Circular Business Model Innovation

RQ – Research Question

SE – Sharing Economy

EU – European Union

SPS – Subsea Production Systems

SURF – Subsea Umbilical Risers Flowlines

NOROG –The Norwegian Oil and gas Association / Norsk Olje og Gass

PDO – Plan for Development and Operation

PIO - Plan for Installation and Operation

Table of contents

List of figures

List of tables

1.0 Introduction

1.1 Chapter Introduction

This chapter introduces the background for the thesis, identifies the research problem and on that basis proposes relevant research questions, which also narrow gaps in the literature. The most basic backdrop is presented first, explaining the sustainability concerns humans face today and how Circular Economy (hereafter CE) can contribute to solving them. Further, the chapter explains how this also applies to the oil and gas (O&G) industry, specifically through sharing across different actors. Research gaps on Circular Business Models (CBM) are identified along with associated barriers towards the implementation. Incentives and barriers towards sharing then creates the basis for the research questions.

1.2 Background

Human activity and the current consumption of natural resources causes depletion of natural systems and global warming. According to the Circularity Gap Report for 2021, 1 billion tonnes of materials entered the global economy, while only 8,6% returned into the material cycles again (PACE 2021, 8). At the same time, we passed a global temperature rise of 1 degree caused by human activities (PACE 2021, 12). Based on these global challenges, there are consensus on the need for change in order to create more sustainable systems (Bocken et al. 2016). Sustainable development involves the ability to “meet the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland et al. 1987, 37).

CE is therefore proposed as an alternative economic paradigm to accommodate sustainability concerns, with the potential to decouple economic growth and further extraction of natural resources (Pomponi and Moncaster 2017). As opposed to the current linear economic system, a take-make-dispose pattern, where resources are extracted, used and disposed, CE aims to keep materials and thus value in circulation as long as possible (Merli, Preziosi, and Acampora 2018). Simply put, CE replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims to eliminate waste through the superior design of materials, products, systems, and, within this, business models (Ellen MacArthur Foundation 2013, 7). CE has derived from different schools of thought, all with the main idea that the linear economic system must be replaced with a holistic, circular view. However, there are many levers to achieve a transition to CE, all with different transition costs. For instance, the development of sharing and virtualization have come far, and costs have dropped substantially at the same time, explaining the entrance of new business models in various industries. Renewable energy on the other hand, which is energy derived from replenishable sources, represents larger transition costs both in terms of capital and a profound change in how energy is used and distributed today. The development also relies on a collective consensus on a change of direction, but it is nonetheless a necessity for a regenerative economic system like CE (Ellen MacArthur Foundation 2015; Selin 2020).

The challenge however is that the world still relies on vast amounts of petroleum – a non-renewable resource. The key fuel trend towards 2030 indicates a global increase in demand for O&G (IEA 2020). It may seem like a paradox, but all the while petroleum demand is present, the O&G industry must become more sustainable. The industry acknowledges this, and it is visible mainly in their investments in renewables and through their branding. For example, when former British Petroleum (BP) and the partly state-owned oil company Statoil changed their names to "Beyond Petroleum" and "Equinor" respectively. The latter referring to themselves as a "broad energy company", and both companies emphasize their ambition to contribute to a sustainable world through zero emissions (BP 2021; Equinor 2021).

Besides, there are also other opportunities, in the development and operation of oil fields, to become more sustainable and use less resources in their core activities. Specifically, that includes asset sharing and collaboration across actors, combined with refurbishing systems to extend the life cycles of products and thus create more value (Ellen MacArthur Foundation 2013). Sharing can prove effective to increase efficiency and lower costs for all parties. Not only in the O&G industry, but it is also visible in the transportation industry, housing, consumer goods and services to mention just a few. Potentially, it represents large cost reductions, for instance, due to less required capital to assets and decreased demand for raw materials (De Jong, Engelaer, and Mendoza 2015). The emergence of sharing is also driven by the technological development in general. Digitalization increases the availability to updated information, which in turn enables a new level of sharing and potentially whole new business models based on that (Ellen MacArthur Foundation 2013).

1.3 Research Problem

The last 40 years, with deregulation of banking markets, globalisation of capital markets, outsourcing of production to low-cost countries and technological development, to mention some, the global consumption of materials has skyrocketed. The decades from 1980 until 2010 has been the longest period with continuous economic growth since the 1920's (Murray, Skene, and Haynes 2017). Knowing that our current economy is only 8.6% circular by 2021 (trending downwards), the traditional, 'take-make-dispose', linear economy is still the norm (PACE 2021). Resources are to a large extent extracted, used, and disposed, without re-entering the economy. This means that CE, despite being a recognized term and an economic model for the future, addressing sustainability challenges, still appears as immature in many industries. This is in line with what Prieto-Sandoval, Jaca, and Ormazabal (2018) point out that much knowledge and many frameworks exist today, but there is a need for scientific research on how the knowledge can easily be transmitted to practitioners. In addition, Korhonen, Honkasalo, and Seppälä (2018), who state that while the concept of CE and its practice have almost exclusively been developed and led by practitioners, (i.e., policy-makers, businesses, business consultants, business associations, business foundations), its scientific research content remains largely unexplored.

Adopting CE also entails changing or adapting to a CBM (Lewandowski 2016). However, innovating business models towards circularity involves barriers, which is the main focus of this thesis. It often requires a set of thinking, planning and competence, which fundamentally collides with status quo. Both internally and externally towards all actors of the supply chain, markets, and society (Vermunt et al. 2019). That is supported by Merli, Preziosi, and Acampora (2018, 718), stating that strategies of slowing the loops require a radical change of consumption and production patterns. The backdrop of that statement is today's overweight of scholars emphasizing strategies for closing material loops rather than on slowing them, in their research towards CBM implementation. They say that while loop-closing mainly focuses on transforming waste into resources, and industrial symbioses, loop-slowing addresses many of the other CBMs. That includes changes in customer's value proposition through access and performance models, extending product value and -lifespan using known CE means as design for repair, refurbishment, upgrade etc. Thus, slowing the loops will to a larger extent challenge the linear business models, rather than only focusing on input and waste creation.

Moreover, Kirchherr et al. (2018) identified a number of barriers towards the implementation of CE in the European Union (EU) by interviewing and surveying experts. However, they did not differ between business models in their classification of barriers. Hence, they suggest to address this limitation in future studies, together with barriers in specific sectors. Guldmann and Huulgaard (2020) conducted a multiple case study on barriers towards circular business model innovation (CBMI). Nevertheless, it is limited to 12 case companies in Denmark, and they call for further research on other companies across industries, potentially uncovering new, relevant barriers. In addition, they study barriers towards CBMI. However, like Kirchherr et al. (2018), they uncovered barriers without necessarily paying attention to the different types of CBMs. Vermunt et al. (2019) did study CBM-specific barriers in 43 case studies from the Netherlands, but they as well recommended that future research should focus on further exploring implementation barriers of different CBMs in a variety of specific sectors. Hence, this thesis aims to uncover sharing-specific barriers towards CE transition in the O&G industry. Against this backdrop, the following research problem is defined:

There is lack of knowledge on CBM-specific barriers in different industries.

Precisely, the barriers in a sharing business model are investigated by conducting a case study. Thus, due to the lack of investigated barriers in specific industries, this study is limited to sharing between exploration and production companies in the Norwegian O&G industry, facilitated by a service provider for subsea operations, and the industry association. Accordingly, sharing makes up its own area of research but has also become an integral part in the body of CE literature and an example of a CBM. That implies that sharing allows for CE means, and thus these two related areas are combined in this thesis. This study, hence, contributes to transmitting knowledge on barriers related to CBM implementation from theory to practice, and vice versa, placing innovative barriers on CBMs into scientific terms. The results can to some extent be valuable in similar sharing cases, and in the further development of the specific sharing platform in markets abroad.

Next, the research questions are formulated.

1.4 Research Questions

The following research questions (RQs) are outlined to uncover the barriers towards the implementation and use of a CBM based on a sharing platform, in the Norwegian O&G industry.

RQ1: What are the incentives for sharing between companies in the oil and gas industry?

RQ1 aims to investigate the drivers for participating and contributing to sharing initiatives. To answer this adequately, it is necessary to create an overview of the relevant actors in the specific industry and map the potential stakeholders in the sharing solution, exemplified in Section 2.2.1. Further, which assets will be shared among the users of the platform and what the stakeholders reflect upon regarding incentives, i.e., what the pain and gains are, will also be examined. This RQ1 also expounds on whether the sharing platform changes the dynamics regarding dependency between suppliers and customers due to minimized transaction costs (Piscicelli, Ludden, and Cooper 2018).

Another consideration is the extent to which incentives are driven by internal or external factors. Do the stakeholders implement CE due to sustainability concerns, or are they related to or driven by lasting competitive advantages? Govindan and Hasanagic (2018) also mention policy, health, society, and product development as possible drivers.

Having looked at basic incentives for sharing, we begin to ask ourselves what the barriers are.

RQ2: What are the barriers towards implementation of a sharing platform in such an industry?

For a sharing platform to benefit from network effects and thus succeed, there is a prerequisite that enough actors participate in the solution (Piscicelli, Ludden, and Cooper 2018). Apart from that, the literature provides many other barriers towards sharing platforms. As such, this RQ2 seeks to uncover which of these barriers are relevant for this sharing case. Examples are barriers concerning competence on CE in all levels of the organisation and in the supply chain as a whole, design issues – whether existing products are designed to prolong their lifespan through reuse and refurbishment, the certainty of demand for the products (market issues), risk of cannibalisation, lack of collaboration, etc. (Guldmann and Huulgaard 2020; Vermunt et al. 2019; Govindan and Hasanagic 2018)

Following this step of uncovering barriers, comes means to address them.

RQ3: How can the identified barriers be overcome in order to realise the potential of a circular economy?

RQ3 aims to assess how the level of circularity can be increased for the shared assets. It is dependent on the findings from RQ2 and will followingly address the uncovered barriers. The suggestions will be based on research and experience from similar challenges.

The primary and most visible benefit is the sharing model, which can increase utilisation and availability of shared assets, and lower the threshold for investments as it can reduce the required capital and thus the risk. However, it also enables other means to increase the circularity, like product life extension through maintenance, reuse, and refurbishment. Additionally, this can also represent economic benefits as more value from the materials are harnessed, generating more revenue before being recycled or disposed of (Ellen MacArthur Foundation 2013; Accenture 2014).

1.5 Structure of the thesis

The thesis follows the steps as provided in Figure 1-1

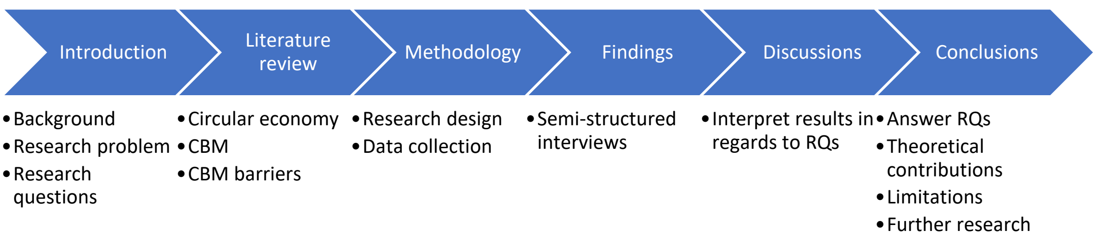

Figure 1-1: Structure of the thesis

2.0 Literature review

2.1 Chapter Introduction

This chapter aims to provide the literature and frameworks relevant for solving the research questions adequately. First, it covers the research on the concept of a CE and its business models, with emphasis on sharing models. The presented research is mainly from the last two decades due to the quick development in the field. Especially new CBMs are based on modern technology and consumer habits, and thus the research quickly becomes obsolete. Thereafter, the chapter will elaborate on the barriers towards implementation of CBMs. In addition, a brief introduction to the Norwegian subsea industry is presented, creating a foundation for the case study.

2.2 The concept of Circular Economy

The term CE has no defined start. It has rather developed through the years based on different concepts and schools of thought, and has now become an independent term in academic research (Merli, Preziosi, and Acampora 2018). Scholars disagree on the relation between CE and sustainability, and the impact CE and CBMs have on sustainability. However, CE is often used in the same contexts. According to a literature review conducted by Geissdoerfer et al. (2017), CE can represent means towards the creation of sustainable systems by problematising and solving the consumption linear economy constitutes. They further state that in the literature, CE is seen as a trade-off, a beneficial relation, or a condition for sustainability. That being said, the following definitions do not include sustainability, but rather emphasizes the holistic, cyclic perspective.

Definitions

CE is considered an umbrella concept, and thus various definitions exist (Rodríguez et al. 2020). Here are three widely used definitions, which capture the essence of the core aspects:

> ”*… a circular economy is restorative and regenerative by design and aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles*”

(Ellen MacArthur Foundation and McKinsey Center for Business and Environment 2015, 46)

The term emphasizes the minimization of material use and waste creation, through making use of the materials already in the loops. The terms “restorative” and “regenerative” are associated with the ability to restore degraded natural systems and instead harness resources sustainably. Murray, Skene, and Haynes (2017) present an alternative definition without referring to cycles, but still capturing the holistic view of the impact economic activities constitute on ecosystems:

> “*an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being*” (Murray, Skene, and Haynes 2017, 370).

An alternative definition is,

> “*a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling*” (Geissdoerfer et al. 2017, 759).

The definitions are overlapping to a large extent, and both are based on the CE systems diagram as illustrated in Figure 2-1. However, this thesis uses Geissdoerfer’s definition, as basis when discussing CE, mainly because it includes relevant and specific means to enable circulation of materials.

Schools of Thought and defining contributions

Boulding (1966) is considered one of the contributors to CE when describing and problematizing the way humans always have looked upon earth’s resources as unlimited, due to always existing frontiers which were to be explored. With the knowledge of earth as a closed sphere, he then highlights the consequences of not having a holistic view of resources and is thus considered one of the first contributors in the development of the CE term. On the same basis of finite resources, Stahel (1982) emphasizes how a spiral-loop pattern, which mainly entails expanding the lifespan of products, will impact the demand and depletion of natural resources, and in turn minimize waste creation. In addition, when introducing the terms reuse, repair, reconditioning and recycling, he claims that industries providing services related to these activities will create large amounts of locally sourced, labour intensive jobs, instead of large capital-intensive companies - the "performance economy". Further, Frosch and Gallopoulos (1989) continue to problematize the amount of continuous raw material input required in a modern society. They illustrate the challenges associated with the consumption at the time in USA, and which consequences it would get if the rest of the world achieved the same wealth and consuming habits. The proposed solution is a change towards what they call "industrial ecology", inspired by nature's own processes, where waste in one process is input in another process. The cyclic view of materials is highlighted, where extensive recycling lessens the demand for virgin raw materials, ultimately benefitting the environment and preventing material scarcity. Accordingly, the term CE first appears in 1990 when Pearce and Turner (1990) examine the lack of including environmental interaction in the economic models. Instead of advocating for a whole new set of environmental economics, they seek to include environmental and waste concerns into the current economic paradigm.

Another influence in CE is what is referred to as "regenerative design", which aims to maximize utilization of materials through minimizing waste and the reuse of materials with the use of renewable energy. That includes ensuring that materials enter back into the material flow rather than disposal (Lyle 1996, cited in Rodríguez et al. (2020)). As a reaction to the focus of eco-efficiency on minimizing waste and emissions in production- and consuming phases, Braungart, McDonough, and Bollinger (2007) propose eco-effectiveness as an alternative approach. It is a more holistic view of the material cycles, incorporating economic, social, and environmental benefits. To achieve that, Cradle-to-Cradle (C2C) design is proposed as a design framework for "… creating products and industrial systems in a positive relationship with ecological health and abundance, and long-term economic growth (Braungart, McDonough, and Bollinger 2007, 1337). While most of the present recycling is downcycling, which gives materials a lower grade of quality after use and ultimately leading to disposal, C2C design creates "metabolisms" that allow materials to upcycle and benefit both economic and environmental concerns. Ideally, that means recoupling the economic and ecological parts in the models, an element that Pearce and Turner (1990) also pointed at. The "metabolism" view on product circulation, split in a biological and technical part, is what is illustrated in Figure 2-1. Products circulating in the biological cycles, thus, products of consumption, are biodegradable and can enter into biological purposes after their intended use cycles. Whereas, the technical cycle refers to those technical nutrients, or materials that must remain in the cycle at the highest possible level through many lifecycles by being reused, repaired or refurbished (Braungart, McDonough, and Bollinger 2007).

Lastly, the CE concept is also majorly influenced by "Biomimicry" and "The blue economy" (Rodríguez et al. 2020). Biomimicry states that nature, through billions of years of problem-solving, has many answers and can serve as a model for how humans should design products and solve technological challenges today. The blue economy, on the other hand, challenges the current economic model in a profound way, proposing a model where there is no waste, basic needs are produced locally and everything consumed is input in other processes (Rodríguez et al. 2020).

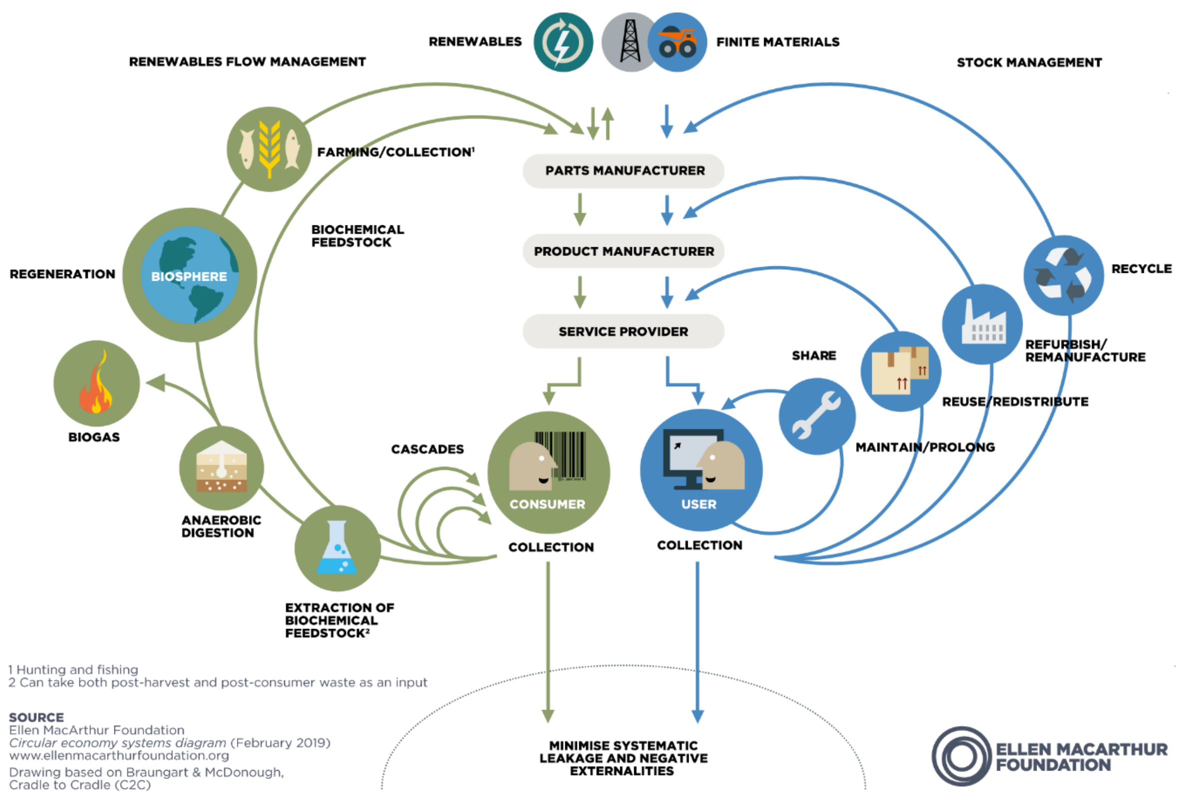

Figure 2-1: Circular economy systems diagram

(Ellen MacArthur Foundation 2019)

Linear vs circular economy

CE is considered a reaction and an antonym to the current linear economy, also referred to as “take-make-dispose”, which extracts virgin raw materials and creates waste via production and consumption (Murray, Skene, and Haynes 2017). The terms “cowboy economy” and “spaceman economy” were introduced by Boulding (1966), and can be seen as antecedents of the linear and CE, respectively. According to Pearce and Turner (1990), the economy is considered a fully linear system when environmental interaction in economic models is ignored, only accounting for production, consumption, capital goods and utility. Global consumption of raw materials is expected to double within 2060, and waste creation to increase by 70% by 2050, knowing that current consumption of raw materials equals three planet earth’s (European Commission 2020). CE addresses the issues related to the vast waste creation and resource use by introducing the cyclic view, where materials stay in the cycle and serve as new input at the end of their lifecycle. That involves profound changes in all stages, from extraction and design to end-of-use and retrieval, with extensive reuse, repair, reconditioning and recycling of products and materials (Stahel 1982). Ultimately, this can decouple economic growth from environmental degradation and natural resource depletion (Murray, Skene, and Haynes 2017).

Circular economy implementation and application

According to a literature review by Merli, Preziosi, and Acampora (2018), CE studies focus on three main lines of action: changing the social and economic dynamics at macro and administrative level. For example, the European Commission have adopted CE in their legislation and policies towards sustainability and work towards climate targets. Through an action plan, they aim to create policies and frameworks to facilitate and incentivise for increased circularity across regions and industries, and include all parts of the value chain (European Commission 2020). Secondly, there are studies on micro level, examining and supporting firms in implementation of circular processes. Thirdly, there are studies at meso level with focus on the effects of industrial symbiosis. (Merli, Preziosi, and Acampora 2018). Germany, as early as 1996, passed an act to facilitate and direct the industry development towards a “closed loop economy”. It included legislation on tracing, recovery, and design for reuse, to minimize waste generation (El Haggar 2010).

China has also adopted CE as guiding principles towards a more sustainable economic, social and environmental development (Merli, Preziosi, and Acampora 2018). They adopted CE on governmental levels through the “Circular Economy Promotion Law”, which came into force in 2009, aiming to handle the country’s challenges with environmental degradation and resource scarcity (Su et al. 2013).

Indeed, CE aims to create sustainable growth through decoupling the economic growth from continuous extraction and disposal of natural resources. To achieve that, business models must be created on that basis (Murray, Skene, and Haynes 2017). However, since the focus of the study is on sharing platform, this subsequent section describes such a business model in detail relative to the other business models.

2.2.1 Circular Economy Business Models

According to Chesbrough (2010), a business model explains how firms work, commercializes a product or a technology and realizes its value. A circular economy business model (CBM) can be defined as “the rationale of how an organisation creates, delivers and captures value with and within closed material loops (Lewandowski 2016). Today, large corporations and consultancy firms already explore, communicate and apply CBMs to create sustainable market opportunities (Hofmann 2019). There are many different variants and interpretations of CBMs. The models below are partially based on the ReSOLVE framework, which aims to cover the core principles of the CE (Ellen MacArthur Foundation, McKinsey Center for Business and Environment 2015; Accenture 2014).

Circular supply chain

The main characteristic of a circular supply chain (CSC) business model is the use of renewable energy and recyclable or bio-degradable, non-toxic materials. Dependency on virgin materials are diminished due to the use of materials in the material cycles (Lacy et al. 2014). According to Ageron, Gunasekaran, and Spalanzani (2012), one of the main challenges is profitability related. They state that companies change towards sustainability mainly due to governmental regulations. However, companies that perceive increased circularity as an advantage and a mean towards solving relevant challenges can benefit from this financially as well. Similarly, legislations can also serve as barriers towards circularity. Other issues can be the performance of alternative materials and the approval from customers.

Product as a service

Product as a service (PaaS) is closely related to Product Service Systems (PSS), which involves a change towards selling functionality of a product instead of the product itself (Van Ostaeyen et al. 2013). With a PaaS solution, products can be offered in a subscription-based model, which can include service schemes with the option to repair or replace. There are advantages for both customers and manufacturers adopting PaaS. For customers, PaaS transforms large investment capital into smaller expenses, allowing them to reduce the tied-up capital. Also, the customers no longer assume the risk of product failure or responsibility for maintenance. For the manufacturer, the PaaS business model can smooth demand fluctuations and create a predictable revenue stream. It enables the manufacturer to manage resources better, as it creates an overview of how many products are leased out and thus knowledge of the amount of retrievable and reusable materials. As they still own the product, they are responsible for the full product life cycle, which incentivises a design for long-lasting products (Mont 2002).

Recovery and recycling

This CBM has similarities with the C2C approach and industrial symbiosis (Lacy et al. 2014). It exploits the residual value from discarded products or waste from different processes and turns them into new forms of value. The objective is to eliminate the use of virgin materials as input and thus close the material loop. In addition, there is an upside in potential cost savings, both from waste removal from processes and from the alternative sourcing. This business model can include recycling, recovery, and upcycling, among others. Upcycling means that materials or products are given a higher value than originally intended when applied for other purposes (Bocken et al. 2016).

Product life extension

Product life extension utilises the value in products by repairing the product or creating new products based on the old ones. Extended life cycle means more time for value creation and saved costs from avoiding replacements. Products can be reused directly without much work, or they can be upgraded, maintained, repaired, refurbished, or remanufactured before they are reused or resold (Lacy et al. 2014). Technological expertise and knowledge of the product can be important in this business model, in addition to collaboration with the product manufacturer and designer (Vermunt et al. 2019).

Sharing platform

The sharing platform is a business model associated with the sharing economy (Hereafter SE). It is recognized by sharing between two actors, facilitated by a mediator (see Figure 2-2). Even though sharing always has been practiced, technology facilitates for the modern SE, and makes it easier and safer to share between both peers and organisations (Albinsson and Perera 2018). The ultimate benefit is the possibility for higher asset utilisation, which again means more generated value through the product lifecycle, and potentially saved costs for both producers and consumers (Frenken and Schor 2019; Lacy et al. 2014).

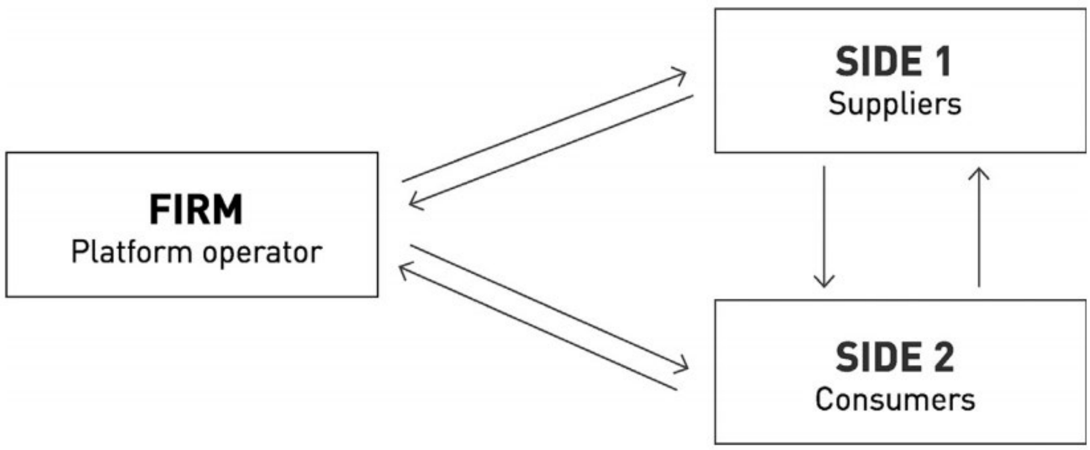

Figure 2-2: Two-sided market

(Piscicelli, Ludden, and Cooper 2018, 4583)

The SE is a relatively new, and thus a fluid term hard to define. The reason is twofold according to Breidbach and Brodie (2017). First, because the research and debate on SE spans from management, technology, sustainability, information systems and more. Secondly, because the research on "sharing" does include obsolete technologies which are irrelevant today. There are different definitions to the term. Slee (2015, 9) describes SE as a "wave of new businesses that use the Internet to match customers with service providers for real-world exchanges", while Cusumano (2014) defines it as "web platforms that bring together individuals who have underutilized assets with people who would like to rent those assets short-term". In the same line of thought, Botsman (2015) calls it "systems that facilitate the sharing of underused assets or services, for free or for a fee, directly between individuals or organisations." Notice that the latter includes organisations as well. A lot of emphasis is put towards peer-to-peer sharing, however, there are opportunities in business-to-business (B2B) sharing as well, involving larger assets with longer contracts (Botsman 2015). Sharing platforms, or multisided platforms often have low capital and operating costs. Due to their positive networks effect, meaning that every new participant makes the platform more attractive for both customers and consumers, they can be valuated higher than their assets and revenues represent. Apart from offering lower transaction costs for the actors (less market friction) than a direct interaction between them, the platform must ensure a critical mass of users to benefit from the network's effects (Piscicelli, Ludden, and Cooper 2018).

Benkler (2004) was an early researcher in the field and suggested that a lot of physical goods with excess capacity can be harnessed better through sharing relations rather than secondary markets. He further on predicted that, together with the development of computational power and population-scale networks, sharing would be increasingly common in many industries, for example in information, culture, computation, and communication sectors. However, he did not state that the SE is a complete paradigm change, but rather an opportunity to create alternative, more efficient business models. The business models of AirBnB and Uber are both based on a sharing platform, and the two are the most well-known examples of SE when their businesses started to thrive from around 2010 (Sutherland and Jarrahi 2018). Along with their success, there was also a criticism with basis in the idea behind the SE. According to Slee (2015), SE originally represented, and is still promoted as, empowerment of individuals through decentralized access to goods and services, which means less dependency on traditional, powerful institutions, allowing access over ownership, reducing environmental footprints – helping both people and planet. The criticism points at the fact that the platform owners themselves have become "corporate juggernauts" and interfere with aspects of our lives which was previously protected, and points that the term "sharing" in this term has become a paradox due to the economic incentives they create and the power they acquire in deregulated markets. In addition, platform owners have been criticised for the way the supply side are treated. Owners profit from privately owned assets and platform suppliers serve as quasi-employees but do not receive employment benefits equivalent to the risk they carry (Constantiou, Marton, and Tuunainen 2017).

Regardless of the criticism, SE is here to stay, and is closely tied with technological development. However, the content in the technology term differs. According to Sutherland and Jarrahi (2018), depending on the use of the term, technology can be an algorithm, a platform, or simply quantifiable trends such as increased computational power or peers' access to digital interaction. Sundararajan (2017) presents three fundamental technological forces as foundation for the SE. The first is the rendering of things as information and the way that information is represented digitally, for example money which is information about your wealth, stored and available in a bank computer. Same applies for music, video etc. Traditionally, physical products now start their life digitally as components and renders into a product. For example, a drug is available as information and is then rendered into a capsule with certain inputs. This allows targeting certain customer segments with the use of algorithms. The second force is the exponential growth of hardware, internet access and miniaturization of digital devices, like smartphones. Third is the "programmability, in a modular way, which enables increased complexity to be aggregated, codified, and eventually integrated into standardized software platforms" (Sundararajan 2017, 53). That substantiates the first two forces and means that you can upgrade, for example, your smartphone without changing it physically, but only by changing the programming or download a new application. Specifically, Albinsson and Perera (2018) outline important technologies that enable sharing (see Table 2-1)

Table 2-1: Technology Capabilities and Relevance to Sharing

Innovation	Date	Implication for sharing
World Wide Web	Formal specification of www – 1990; launch of JavaScript – 1995	Lightweight, accessible platform for presentation and exchange of content, functionality, and media
Web-based consumer commerce	Launch of Amazon – 1994; launch of eBay – 1995	Decentralized peer-to-peer commerce (eBay); introduction of reputation, trust, and recommendation metaphors, which are now widely used
Free consumer e-mail	Launch of Hotmail – 1996	Cheap, flexible means for online communication for all
Peer-to-peer sharing	Launch of Napster – 1999; launch of Wikipedia – 2001	Platforms for distributing media content and information within peer-based communities
Security	Current version of HTTPS specified – 2000	High levels of security leading to widespread trust in Internet commerce (in terms of both exchange of money and security around personal information)
3G phone network	First UK 3G service launched – 2003	Fast access to Internet content on the move
Social media	First full public access to Facebook – 2006	Means of communication; platform for ad hoc and informal groups; establishing online profiles and presence with potential for reputation and trust
Cloud storage and services	Launch of Amazon web services – 2006	Cheap, high volume provision of complex functionality and vast, low-cost storage
High-speed home broadband	Over 50% UK homes access high-speed broadband – 2007	Widespread access at speed that make viable all forms of casual and home use to all. Erosion of "digital divide"
Multifunction mobile device	Launch of iPhone – 2007; launch of android devices – 2008	Allows access to all of the move, at point of need and context aware (e.g. location-based functionality)

(Albinsson and Perera 2018, 76)

Constantiou, Marton, and Tuunainen (2017) categorize sharing platforms based on two dimensions in a matrix (Figure 2-3). The horizontal dimension measures the level of control exerted by the platform owner, and the vertical dimension is the level of rivalry between platform participants. According to the authors, these dimensions are well-known among managers and academics, allowing to demystify the SE platforms, which they claim runs much like traditional businesses, but with innovative use of market mechanisms. Also, the model will help traditional businesses in understanding the characteristics of potentially disrupting business models and identify where similar solutions can be applied.

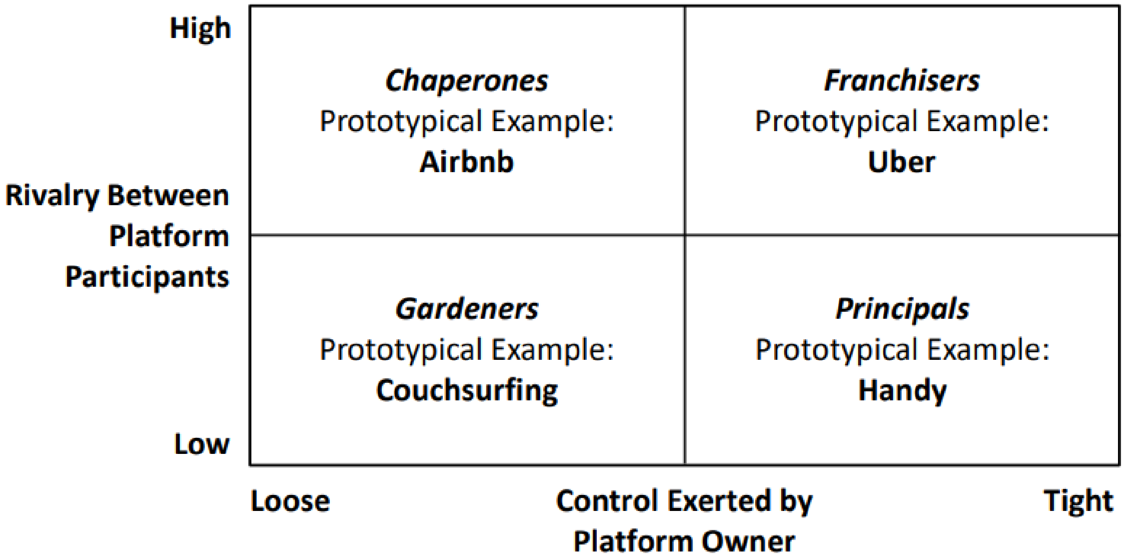

Figure 2-3: Four Sharing Economy Models

(Constantiou, Marton, and Tuunainen 2017, 232)

When implementing CE, there are complex barriers to overcome, which are often dependent on many actors in the supply chain, and this is discussed next.

2.3 Barriers

Many different researchers have studied barriers on CE- and CBM implementation. This section presents a selection of researchers and the categories they sort barriers after (summarized in Table 2-2)

Guldmann and Huulgaard (2020) conducted a multiple case study of 12 Danish companies to uncover barriers in the implementation of CBMs, based on existing sustainable innovation literature. They differ between external and internal barriers in the following categories:

External barriers:

1) Barriers at the market and institutional level: This includes taxation of labour rather than raw materials. This weakens the incentive to repair, reuse, upgrade etc., compared to acquiring new materials. The reason for that is because labour intensive operations then quickly become more expensive. When new materials in addition offer higher quality, firms often choose the latter. Another market aspect is the reluctancy from

financial institutions to support firms adopting CBMs. This is especially more relevant for start-ups.

2) Barriers at the value chain level: Many companies experienced resistance towards changing the current model towards more circularity, mainly because time and money were used on the existing infrastructure, and CBMs could disrupt the current profitable setup for the different actors. In addition, there were difficulties in collaborating across the supply chain partners, especially regarding mutual trust, which takes time to build.

Internal barriers:

3) Organisational: The barriers here were associated with emphasis on existing sustainability measures, often measured through energy efficiency on processes and products rather than on circularity. Additionally, CBMs struggled competing with existing products based on current measures, e.g. return on investment (ROI). Circularity involves longer life spans, something which was not accounted for today. Also, there was concerns on cannibalisation due to longer lifetime of the products, and lack of collaboration and competence on circularity design.

4) Employee level: Some of the companies had experience with using recyclable materials (e.g. from a return system), but the knowledge of CE was limited. That formed a barrier towards further CE implementation. The lack of knowledge was present in managerial levels and hindered a further anchoring Further, uncertainty in market demand, solidity of the business and the fact that current business models were designed for linearity, made it hard to adopt circularity across the organisation.

Govindan and Hasanagic (2018) also assessed CE implementation barriers in a supply chain. Through a literature review they divide the barriers into:

- Governmental issues: These issues address the lack of standard systems for measuring performance of CE in a supply chain, ineffective recycling policies not capable of securing high quality, unclear visions of CE, and insufficiently implementation or absence of laws related to CE.
- Economic issues: Represent the lack of economic incentives to turn the supply chain towards more circularity, in both a long and short term, i.e. a linear economy is still more profitable in terms of both purchasing and production. In

addition, organisations do not internalise the externalities, meaning they do not account for environmental costs.

- Technological issues: Include issues of tracking products and measuring quality through the life cycles and product complexities including design issues for CE.
- Knowledge and skill issues: Lack of reliable information to customers and suppliers, public awareness, and knowledge about CE among employees at all levels.
- Management issues: Poor leadership and limited commitment and support for CE among the leaders in organisations, organisational structures unfit for CE implementation, e.g., inefficient bureaucracy.
- Circular economy framework issues: Business models in the supply chain not suitable for CE, the supply chain needs are not mapped and included, and other solutions than CE are more favourable for the organisations.
- Culture and social issues: Lack of enthusiasm towards CE, reused components are perceived as lower quality and a general scepticism towards change.
- Market issues: Include challenging reverse logistics, ownership issues, legal frameworks, which serve as barriers and limited access of reuse products.

Table 2-2: Overview of barriers in the literature

Author(s)	***Barrier***	***Internal/external***
(Guldmann and Huulgaard 2020)	Market and institutional level	External
	Value chain level	External
	Organisational level	Internal
	Employee level	Internal
(Govindan and Hasanagic 2018)	Governmental issues	External
	Economic issues	Internal/external
	Technological issues	Internal
	Knowledge and skill issues	Internal
	Management issues	Internal
	CE framework issues	External
	Culture and social issues	Internal
	Market issues	Internal/external
(Vermunt et al. 2019)	Organisational	Internal
	Financial	Internal
	Supply chain	External
	Market	External
	Institutional	External
(Kirchherr et al. 2018)	Cultural	Internal/external
	Market	External
	Regulatory	Internal/external
	Technological	Internal

Having presented relevant literature on CE, CBMs, and the barriers towards their implementation, the following section provides an overview of the structure of the O&G industry in Norway. This represents the context where the specific sharing model unfolds.

2.4 Structure of the O&G industry

The O&G industry is the most profitable and influential industry for the Norwegian economy, and employs over 50 000 people in Norway (SSB 2020). Thus, it has also been deemed critical to ensure that the state receives the largest possible share of the value created, so that it can benefit society as a whole. This section explains briefly how the industry is structured, from the point of issuing licenses, to operating the oil fields, to get an understanding of the context of the thesis.

To ensure that the society benefit from petroleum deposits and the associated activities, Norway has enacted robust legislation requiring companies to obtain licenses and approval from competent authorities for all phases of petroleum operations. The Petroleum Act establishes that "The Norwegian state has the proprietary right to subsea petroleum deposits on the Norwegian Continental Shelf" (from here: NCS) (Norwegian Petroleum 2021; Act of 29 November 1996 No. 72 relating to petroleum activities 1996).

2.4.1 Awarding of licenses

The granted production license gives exclusive rights to petroleum discovery, exploration drilling, and production. Licensees become the owners of a share of the oil and gas produced proportional to their share of the ownership.

> *In each case, the Ministry designates an operator for the joint venture, and this company is responsible for the operational activities authorised by the licence. The licensee group finances the activities jointly. Each licensee is expected to make use of its own particular expertise, and all the licensees have a responsibility for controlling the operator's activities (Norwegian Petroleum 2021).*

Figure 2-4 presents the Exploration and Production Companies on the NCS based on number of operatorships (referred to as operators in this thesis). Note that a license is awarded to a group of companies with a designated operator in the lead. This enables sharing of competence between more experienced companies and smaller companies. In addition to that, a group of companies constitute a control mechanism, ensuring competition and that the decisions are well-founded (Norwegian Petroleum 2021).

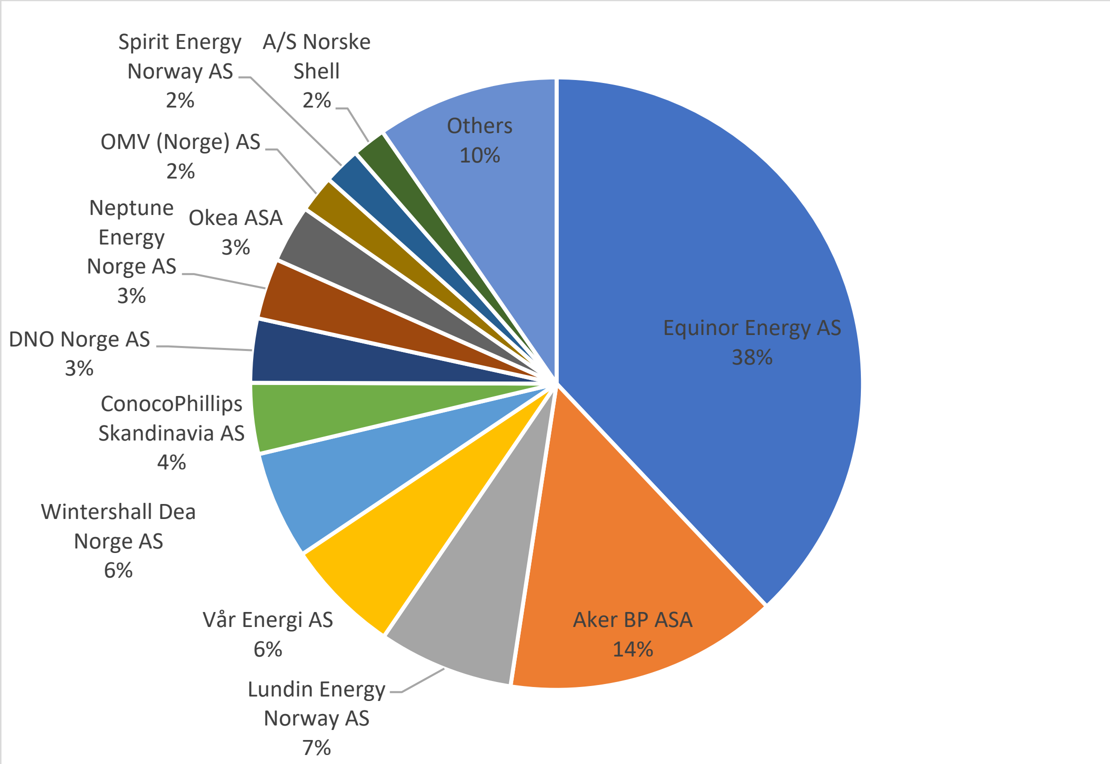

Figure 2-4: Exploration and Production Companies on the NCS based on number of operatorships

(Norwegian Petroleum 2021)

If the licensees make a discovery and wish to develop the field, the license is extended from the initial 10 years to 30 years. Thereafter, the licensees submit a plan for development and operation (PDO), for approval from the Ministry of Oil and Energy. In addition, a plan for installation and operation (PIO) is provided if the project includes pipelines or terminals onshore (Norwegian Petroleum 2021).

From here on, the detailed planning and engineering continues, and operation of the oil field begins. The scope of this thesis is limited to this phase, specifically to subsea development, operations, and maintenance.

2.4.2 Norwegian Subsea Market

Since the beginning in 1969, the government has facilitated for building national competence across all operations. As an effect, a large share of the employment in O&G industry operates in the service and supply industry. In 2017, the industry had a total revenue of 340 billion NOK, where the international share constituted 29% (Rystad Energy 2018; Regjeringen 2016).

The Subsea companies operates within the Service and Supply industry. These companies are specialized in developing and operating fields below the surface through all phases, from engineering to maintenance and decommissioning services (marked red in Figure 2-5). They usually operate on contracts awarded by the operators. Many of the subsea actors are large global corporations with production facilities, offices and competence located in Norway, including TechnipFMC, Subsea 7, Aker Solutions et al. (Figure 2-6Figure 2-1).

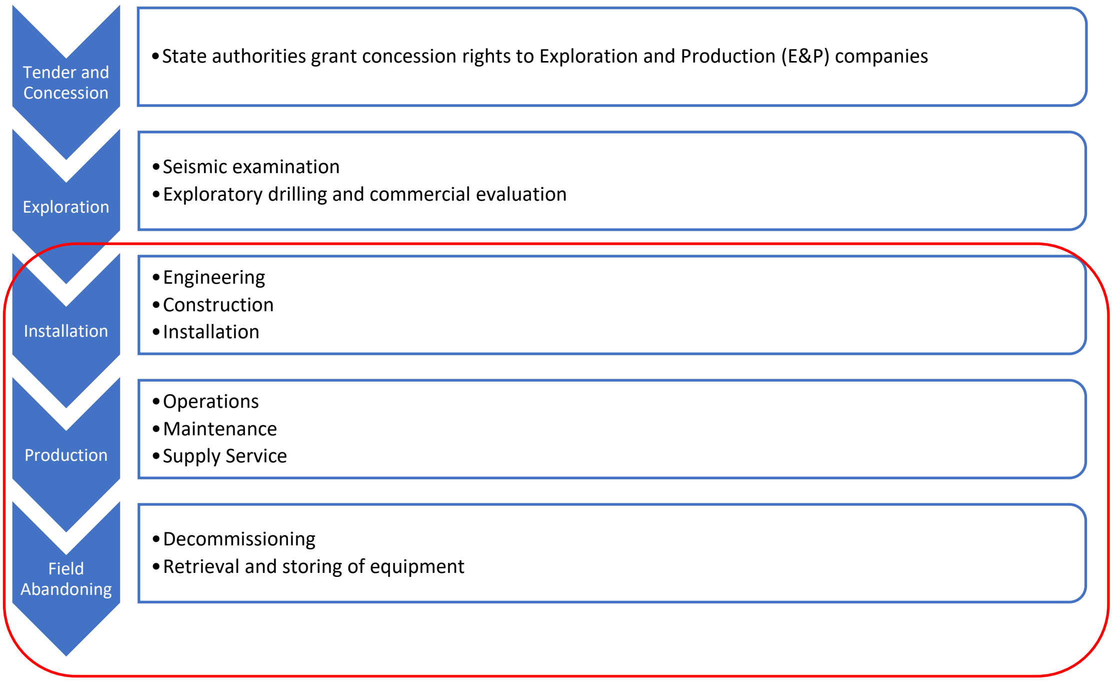

Figure 2-5: Value Chain for Upstream Subsea Oil and Gas Field

Developed from Olesen (2015, 20)

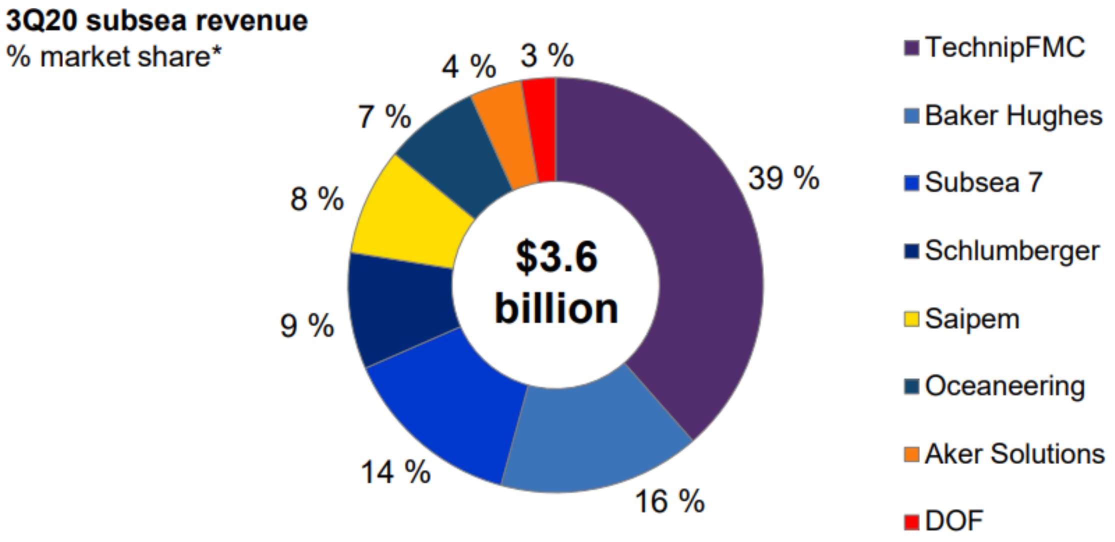

Figure 2-6: Subsea revenues for top eight subsea players

(Rystad Energy 2021)

When a project is developed, the contracts from the operators are usually split up in two different parts, the Subsea Production Systems (SPS), and the Subsea Umbilical Risers Flowlines (SURF), both including fabrication and installation. However, lately some companies merge the two contracts, making the scope twice as large (Rystad Energy 2021). SPS are equipment and systems on the seabed necessary for extraction of hydrocarbons from subsea wells, and for the transportation through pipelines to a production facility located onshore or offshore (NORSOK 2015). Umbilical in the SURF term refers to the connections between the subsea equipment and the platforms or floating production units. The cables allow for production control, chemical injection, subsea pumping and processing. Risers are a conduit, which transport hydrocarbons from the sea floor up to the production unit. Flowlines are the pipelines connecting well-heads to a process equipment (2B1st Consulting 2012).

Following the literature review, comes the description of methodology.

3.0 Methodology

3.1 Chapter Introduction

This chapter explains how the research was conducted and the reasoning behind the chosen methods. The research onion, developed by Saunders, Lewis, and Thornhill (2016), serves as a guideline for the chapter (Figure 3-1). The two outer layers, philosophy, and approach to theory development serve as a way to reflect around this research and will only be discussed briefly. The emphasis in this chapter is put towards the four inner layers: methodological choice, strategy, time horizon, and techniques and procedures. Each of the six layers will be presented separately or combined in the following sections.

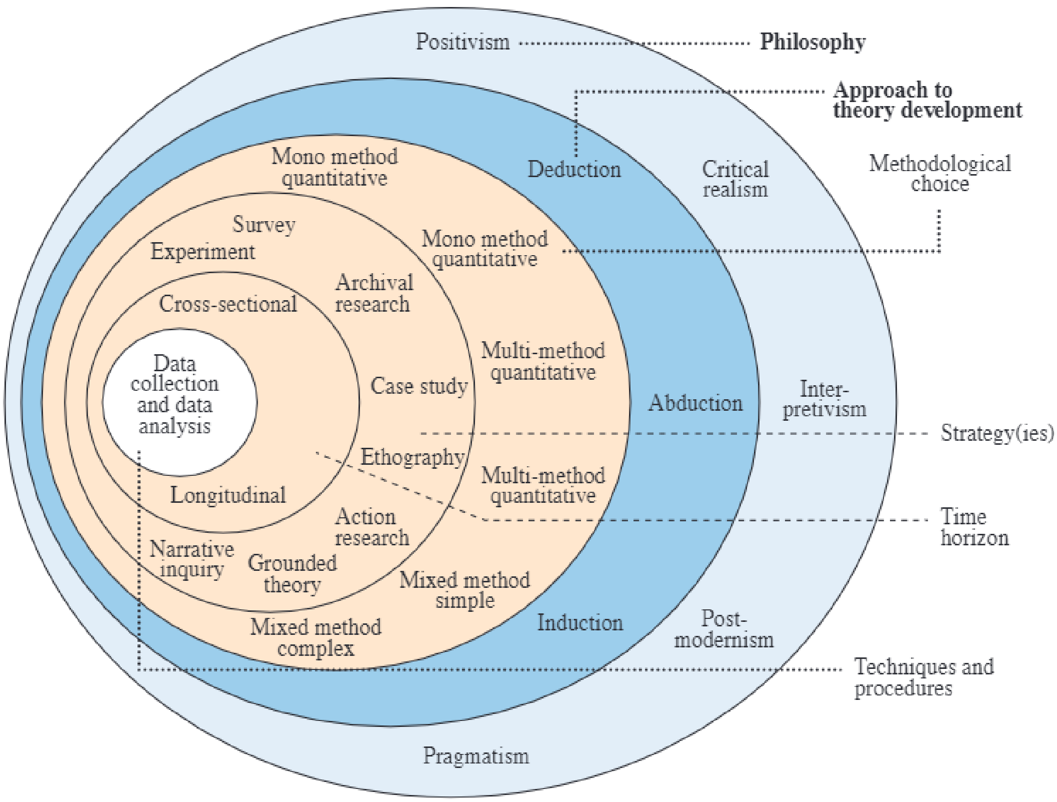

Figure 3-1: The Research Onion

(Melnikovas 2018)

3.2 Research philosophy and theory development

Research philosophy are beliefs and assumptions about the development of knowledge (Saunders, Lewis, and Thornhill 2016). When conducting research, the researcher will always make some assumptions about the surrounding world. As they will affect the research, it is important to reflect upon them before, during, and after the research process. The assumptions are split into three different types: ontology, epistemology, and axiology (Saunders, Lewis, and Thornhill 2016).

Ontology asks what nature of reality is. In the context of writing a thesis, this is relevant because my ontological assumptions include how I see the world, and followingly how I see the research objects, thus, the organisations, the people, and the industry. For example, I would naturally have my own thoughts about the O&G industry, or I could think that SE and CE are utterly underutilised solutions that can solve all problems. Even though the research is attempted to be balanced, my subconscious perceptions would still exist, and could possibly colour and influence the results.

Epistemology is assumptions about knowledge, and questions which types of knowledge is acceptable, valid, and legitimate (Saunders, Lewis, and Thornhill 2016). The relevance for epistemology in regard to this thesis is to which extent the methods applied are recognized, and if they allow to communicate the knowledge in a legitimate way.

Axiology is about how the researcher's values impact the research process. In the first instance, it questions why the specific topic was chosen above other topics, and whether there is a reason for that, based on values. Further, it asks the same when it comes to data collection – do I acknowledge only quantitative data and results, or do I think that a qualitative approach can be just as good by revealing (inter-)personal experiences and case specific incidents and thus give a better description of the research area?

All these three facets of philosophical underpinnings have been reflected upon during the writing of this thesis. Some are more abstract than others, but together, they create a consciousness about important aspects of the approach and choice of research area. Saunders, Lewis, and Thornhill (2016, 136) list five different research philosophies based on ontology, epistemology, and axiology. These are positivism, critical realism, interpretivism, postmodernism and pragmatism. The research philosophy interpretivism is most suitable for my thesis, based on my reflections throughout the research process. Interpretivists researchers can work inductively, evaluating their data, discovering themes and patterns, and eventually locating this in existing literature to refine, extend, or generate theory (Saunders, Lewis, and Thornhill 2016). As the thesis is based on and motivated by a current issue of barriers, but with limited literature on CBMs in the specific industry, interpretivism seems like a natural philosophical approach.

In theory development there are three main approaches, deduction, induction, and abduction. Where deductive conclusions are based on logical reasoning from a set of premises, induction explores the gap in the logic argument between the premises and the conclusion (Saunders, Lewis, and Thornhill 2016). For the sake of this thesis, an inductive approach is applied, as the scope is limited by RQs, and the purpose is to extend the theory on barriers towards CE and CBM in a specific industry. The RQs set certain premises, namely that there are incentives for sharing, there are barriers, and followingly, the barriers can be overcome to realise increased circularity. Subsequently, existing literature within CE, SE, and barriers are examined to see if the premises hold. The literature offered an advance in understanding the RQs. Then data were collected, discussed, and put up against the RQs and the literature. That created the basis for extending the theory where it didn't fit the specific industry and its issues, together with suggestions for further research.

This section has provided reflections about research philosophy and approach to theory development. They are to some extent abstract, but nonetheless, they form the basis for the research design, which represents the next three layers of the research onion.

3.3 Research design

The research design is the plan on how to answer the specified RQs, and includes how I collected data, the time horizon, from which sources, and what obstacles I encountered, both practical and ethical (Saunders, Lewis, and Thornhill 2016).

Methodological choice and purpose of my research design

This is the choice between quantitative, qualitative, or mixed methods. The methods represent different advantages, and the choice depends on the research area, access to relevant data, and the RQs, among others. I have justified a qualitative approach based on certain reflections around the research, presented by Richards and Morse (2007, 29):

1. Is the purpose to understand an area where little is known or where previously offered understanding appears inadequate?

There are lots of information about SE and CE in the literature. However, the settings are often different from this case. In terms of sharing, I have found little research about sharing of high value equipment between a limited number of users, as the case is in the Norwegian O&G industry. That means I am not sure about what I can expect to find, and if the findings are directly comparable to the literature, where the emphasis is on peer-to-peer sharing with significantly larger numbers of participants. Regarding CE, the literature is more comparable, but I was unsure about the extent to which CE was a driver for the actors to explore the sharing initiatives. In addition, it would be challenging to uncover the RQs using a quantitative approach without the knowledge obtained through the interviews. There would also be an issue with sample size, given the limited number of actors using the sharing platform.

2. Is the purpose to make sense of complex situations, and changing and shifting phenomena? Is the purpose to understand phenomena deeply and in detail?

The phenomenon of sharing in the O&G industry involves many barriers, which would be hard to uncover without understanding the complex relations between the actors. That knowledge would be hard to obtain and interpret with a quantitative approach, where the relevant people would not have the possibility to explain it through interviews. In addition, it examines the issues detailed, rather than a broader understanding of common barriers.

3. Is the purpose to learn from the participants in a setting or a process the way *they* experience it, the meanings they put on it, and how they interpret what they experience?

This elaborates on the previous point. The sharing initiatives are in an early stage, with complex barriers depending on many factors, including the views from key personnel from the different organisations. In addition, the organisations face different barriers, which in my opinion are best covered with a qualitative, in-depth approach.

4. Is the purpose to construct a theory or a theoretical framework that reflects reality rather than your own perspective or prior research results?

I do not aim to construct a new theoretical framework. However, as stated above, not all existing theory fits this case study. Thus, some new aspects or barriers can be uncovered during the research, and the theory can be extended.

To sum up, based on the argumentation above, a mono-method qualitative approach was chosen for this thesis. The purpose of the research design is of exploratory character, which is best suited to clarify my understanding of the phenomenon through interviews and studying literature. Exploratory design is characterised by problems which are not necessarily clearly defined, aiming to provide a better understanding of the issues, and creating a basis for further research (Saunders, Lewis, and Thornhill 2016). For this thesis being, it means that due to limited knowledge on incentives and barriers in the O&G industry, I must explore which issues exists there. Then, compared to the existing literature, provide an understanding of the issues.

Next, the research strategy is reflected upon.

Research strategy

Generally, a strategy is a plan of action to achieve a goal. In this context, the goal is to answer the RQs adequately, so the research strategy reveals how I planned to go about and do so. The strategies compatible with a qualitative methodology are Archival and Documentary Research, Case Study, Ethnography, Action Research, Grounded theory, and Narrative Inquiry (Saunders, Lewis, and Thornhill 2016, 177).

Multiple case study is the best description for this thesis. It is suiting for in-depth inquiry into a topic or a phenomenon in its real-life setting, and can refer to organisations, change processes, events, and so on (Saunders, Lewis, and Thornhill 2016, 184). The case in this thesis refers to the implementation and use of the sharing platform "Subquip". The context where it unfolds is in the Norwegian O&G industry. Other important contextual factors include the organisation CCB Subsea, which have developed the sharing platform, the industry association Norwegian Oil and Gas (hereafter NOROG), which have acquired and now run the sharing platform, and the users of the platform (operators). Further, Subquip is part of a broader sharing project initiated by NOROG. In other words, there are many actors, the context is complex, and it is therefore relevant to acquire an in-depth understanding to the encountered issues. This variety of stakeholders also explains why it is a multiple case study. Even though much emphasis is put on the case of the CBM Subquip, I have studied multiple companies (users) to understand the differences and the similarities between the cases.

This is a sharing case where the actors are of different sizes, have different needs and thus encounter different issues. Based on that, I chose to collect data through interviews, from organisations that represent the whole spectre. An introduction to the represented companies is provided in Section 4.2.2. My path to get in touch with relevant representatives was through CCB Subsea, which had been working with these people during the development of Subquip. Primarily, emails were used to send inquires for interviews, however, I sometimes had to call if they did not reply within reasonable time. The inquiry for interviews is available in Section 8.1 Appendix.

Next follows reflections around time horizon and ethics.

Time horizon and ethics of the research design

As for time horizon, it can be considered a cross-sectional study, due to its limited timespan. The interviews were conducted over a short period of time from February 2021 to April 2021. However, the development of the sharing platform Subquip has spanned over several years, and it is also of interest to look at the emphasis different interviewees put on historical happenings.

Ethical concerns emerged as I worked with the strategy and as the research progressed. In this research context, ethics "refer to the standards of behaviour that guide your conduct in relation to the rights of those who become the subject of your work, or are affected by it." (Saunders, Lewis, and Thornhill 2016, 239). There are many potential concerns, but I will list the most relevant ethical principles I have encountered and reflected on during the research:

- Integrity and objectivity of the researcher:

To appear with integrity, all processes have been transparent. That includes towards the interviewees, where they were informed about the aim and scope of the study, and which actors I wished to speak to. As I intended to speak to potentially competing actors, I found it appropriate to inform them about that. The alternative would have been to be more reluctant with my information, and potentially uncover even more conflicting views, but there was no guarantee for that, and I figured it could increase the scepticism and make more harm than good. Also, that would constitute a threat for the interviewees to withdraw their consent. In the extent of that, I have asked more or less the same questions to the different interviewees. If there was a potentially conflicting theme, I have included questions that cover the same, but avoided to include the opinions of competing actors.

- Privacy of those taking part:

All interviewees participated voluntarily and were informed that they could withdraw their consent whenever they wished. Their personal name is excluded, but the name of the employer is identified in the thesis. This is stated in the application to Norwegian Centre for research Data. The opinions and statements are attributed the interviewees, and not as official company opinions. The respondents are identified using the employers name (e.g. Equinor Energy_R1, etc.).

In the extent of being aware of one's conduct, it is highly important to reflect and discuss if the research measures and observes what it aims for, and if we can trust the collected data. These are questions of the validity and reliability of the research.

Validity

> *"In the social sciences, validity usually means whether a method investigates what it purports to investigate"* (Kvale and Brinkmann 2009, 327).

Validity in this context is about "the interdependence of philosophical understandings of objectivity and truth, social science concepts of validity, and the practical issues of verifying interview knowledge" (Kvale and Brinkmann 2009, 241). I will explain the validity of this thesis by differing between construct-, internal-, and external validity, as presented by Yin (2003) .

Construct validity deals with the measures being taken in the research, and whether they measure the right phenomenon. In qualitative research, the problem of bias of the researcher also becomes apparent. For this thesis, the questions informants were asked, were derived from meta-studies on barriers to CBMs. That increases the probability for asking more accurate questions relevant for CBM barriers and CE. Regarding the bias, the most important is perhaps reflections around my independence towards the different organisations which I interviewed. I have no commercial or personal interest of importance towards any of the organisations. That can contribute to a more neutral approach for me as a researcher. I have also been careful to make clear which quotes and reasoning from informants create the basis for my claims and findings. In addition, the thesis is reviewed by my supervisor, and feedback is received throughout the research process.

Internal validity is the extent to which causal relationships can be derived from the research. The way I have compensated for this, and thus increased the construct validity, is by interviewing seven different people in management positions, from six different companies. This makes the findings more comparable, and thus their different perceptions and explanations to certain phenomena can contribute to a more balanced view, hopefully uncovering the "truth". That being said, there is always an inherent risk for me as a researcher to misinterpret the informants and failing to reproduce their opinions and standpoints. In addition, the informants could have held back information which could explain a reluctancy to sharing – something which they would find sensitive, for example company strategies or confidential contracts with certain organisations.

External validity measures if the findings in this particular study are valid for other cases, outside of this context. The level of such transferability is hard to determine, but the uncovered barriers in this research fit the barriers found in existing literature to a large extent.

Reliability

> *"Briefly, reliability requires that the same results would be obtained if the study were replicated (...)"* (Richards and Morse 2007, 190)

In practice, qualitative studies are very hard to replicate. This is also one of the reasons why reliability in qualitative research is disputed. However, for this thesis being, the most important thing to secure reliability has been to clarify my approaches, and the different steps during the research process. Also, the interviews, which constitute the database, are transcribed.

Until now, this chapter has focused on more conceptual issues. Next, more concrete steps are accounted for, specifically my approach to data collection through interviewing relevant informants.

3.4 Data collection and analysis

This section reflects the practical steps undertaken in the process of collection and analysis of data through semi-structured interviews. The process has followed "the seven stages of an interview investigation", presented by Kvale and Brinkmann (2009). Some of the stages cover moments found earlier in the methodology and are thus kept short.

Thematising

Thematising is the work done prior to interviewing and includes the formulation of RQs and the outlining of research purpose, investigating the themes and literature, and get acquainted with adequate methods.

In my case, this was started in conjunction with the course "LOG904-100 20H Proposal Presentation", autumn 2020. I got in touch with the organisation CCB Subsea through a relative which knew they were developing a sharing platform. During an informal virtual meeting (with CEO, Lead Engineer, and a consultant), we discussed which challenges they experienced, and further, which of these could be interesting and relevant for me to investigate. I found barriers of sharing among the users, as an interesting and suiting focus. Based on that, and on existing literature on the subject, the research gap was uncovered, and purpose of the study was concretized, as found in Sections 1.3 and 1.4, respectively. Lastly, a tentative plan on data collection and analysis was made. It was based on interviews with actors having different perspectives or conflicting needs, with basis on CE literature and barriers to CBMs.

Designing

Designing the study includes all the steps provided in the "research onion (Figure 3-1) and was done during the whole research process. This plan made it easier to see the whole process and ensuring a coherence between the purpose and the applied methods. A schedule of the process is provided in Appendix 3: Schedule.

Interviewing

The interview is probably the most crucial step during the data collection process and requires thorough preparation. The first issue was finding informants who could answer to the RQs. As I already had talked with CCB Subsea, that was a natural way to get in touch with other informants, and they gave me names of customers, suppliers, and other relevant persons, in which I contacted by email and requested for an interview (see Appendix 1: Interview request). I had to call some of the informants who did not respond to the emails sent. That accelerated the process, and they were all willing to participate. In addition to customers and suppliers, I sent a request to the industry association NOROG. Apart from being the owner of the sharing platform, Subquip and facilitator for sharing initiatives in the industry, they do not have a direct commercial incentive, and could hopefully provide an impartial view on the challenges and barriers.

Next, I designed an interview guide based on the literature on CE, SE and barriers to CBMs (see Appendix 8.2). The interview guide was split in three, based on the RQs. The first RQ asks about the incentives for sharing. The second and third were aimed to uncover barriers and ask for means to solve them. These were combined, so that I followed up on every barrier consecutively, asking how it could be overcome. That way, the connections between barrier and corresponding solutions were easier to capture. Under every RQ, there are many sub-questions, covering different areas of the literature. Most of them were formulated asking “how”, “why” and “what”, and I put emphasis on not asking leading questions or communicating any opinions in the way I asked them.

All the interviews were conducted digitally, using Microsoft Teams. We usually made an appointment, and then I sent an invitation which they accepted. This was successful, and all interviews were conducted on schedule. I sent the interview guide in advance, for them to prepare and get an overview of the subjects. Often during the interviews, they covered questions in different parts of the interview guide. However, I tried to not interrupt them, as I saw that the connections were not always as set up in the interview guide. The most important was that the different subjects were covered, and I asked follow-up questions where necessary. Most informants were very willing to talk, so my role as an interviewer was mostly to keep them inside of the relevant subjects, as semi-structured interviews suggest.

Transcribing

All the interviews were recorded with the informants' consents. This allowed me to transcribe the interviews literally. Transcription does not capture the interpersonal connection between me as the researcher and the informants, but the fact that the interviews were done virtually minimized this non-verbal communication anyway. I chose to transcribe the interviews word-by-word (manually), as this made the transcription process more effective, and I could be sure that this was what they actually said, when citing directly in the thesis. This can also increase the reliability of the study. However, I did not include the "mh's" in between words and sentences, as they did not contain any meaning, nor did they reproduce any emphasis to the answers from the informants.

Analysing

The many pages of transcription are a direct reproduction of a conversation. Thus, in the analytic phase, the aim was to reshape the words and sentences into meanings. I processed the data using the technique called meaning condensation, where "long statements are compressed into briefer statements in which the main sense of what is said is rephrased in a few words." (Kvale and Brinkmann 2009, 205).

First, I read through the interviews to get an understanding of the whole and how they covered the different questions. Depending on their content, I then sorted the citations according to the incentive or barrier, and made an overview shaped as a mind map, using an online tool called Miro (see Figure 3-2).

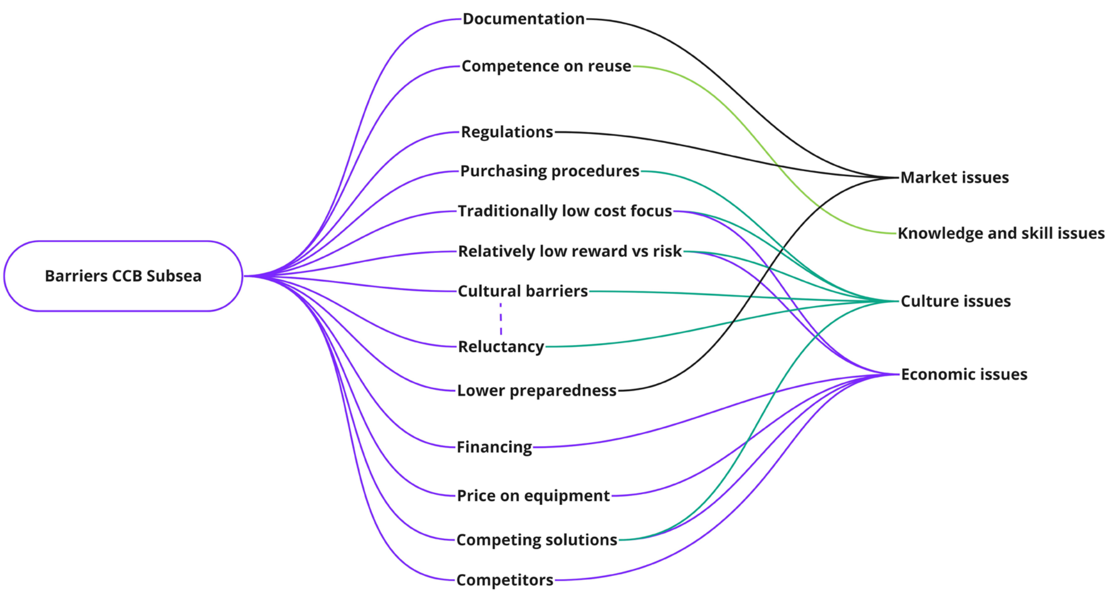

Figure 3-2: Setup for sorting barriers and incentives

The citations were connected with a comment to the corresponding category. These categories were based on what came forward in the interviews. I then appointed each of the uncovered barriers to the corresponding barrier as presented in the literature (Figure 3-2). The categories of barriers to CBMs in the literature are based on literature reviews. That makes them broad in order to fit all barriers. However, very specific barriers for this thesis are elaborated on. This procedure was done with all the interviews. During this phase, it was important to note that many meanings could not be extracted by single sentences – they had to be based on longer reasoning, sometimes several minutes of talking. Additionally, barriers that were uncovered early could also have a connection to something said later in the interview, if the informants remembered something relevant.

Verifying

This stage is already covered in Section 3.2 about validity and reliability.

Reporting

The findings are presented in a way that clearly represent the different motivations and experienced barriers from the informants. During the reporting, it was also important to take the methodological choices and ethical aspects into consideration, to turn the gathered data into a thesis as reliable and valid as possible. I uncovered a lot of barriers during the interviews, too many to be covered by this thesis alone. Thus, I had to prioritize, and go forward with the ones I found most relevant and critical.

In the subsequent Chapter, the present study's findings are presented.

4.0 Findings

4.1 Chapter Introduction

This chapter presents the findings from interviews with six stakeholders from the sharing initiative. Seven interviews have been conducted. First, a case description is provided to explain the context, together with an introduction of the case companies and the informants. Thereafter, the data from interviews are presented according to the RQs, meaning every company is presented, followed by their motivations for sharing, their experienced barriers, and means to overcome them. The respondent's names are anonymized, but position and employer are included. The direct citations are referenced with company name, followed by the respondent number, e.g. CCB Subsea_R1.

4.2 Case description

4.2.1 Subquip

Subquip is a digital platform, whose aim is to facilitate sharing of subsea equipment across operators in the Norwegian subsea industry.

> *Because of the enormous amounts Norwegian oil companies have invested, the industry at large sits on a vast and costly portfolio of first-class equipment. This equipment is, however, to little extent utilized in the operations phase after installations are completed. There is great room for improvement when it comes to: utilization, economizing, capitalization, efficiency improvement, and green thinking (SubQuip 2021).*

Formally, the development was done by CCB Subsea. Evry was hired to develop the technical solutions, Innovation Norway funded the project, and two other operators (Shell and Lundin) were also involved in the process. In 2019, NOROG acquired Subquip, and it became a part of their sharing initiative across the industry. All 12 companies which run subsea operations in Norway are to some extent engaged in the Subquip sharing initiative today.

The idea behind Subquip, as seen in Figure 4-1, is to make use of and share the excess equipment between the operators. The operators visualize their available equipment and tools through the Subquip portal (Figure 4-2). After requesting the item, a contract template based on predefined agreements between the operators is created, and the sharing can be formalized. Sharing can also be done on unique premises agreed on between the supplier and the consumer. The box marked "service providers" shows where engineering companies can be engaged. As subsea operations are highly complex, and use of existing equipment can involve modifications, third party expertise is often required. However, as per now, these companies do not have access to Subquip, only the operators have. More on that in the "barrier" section.

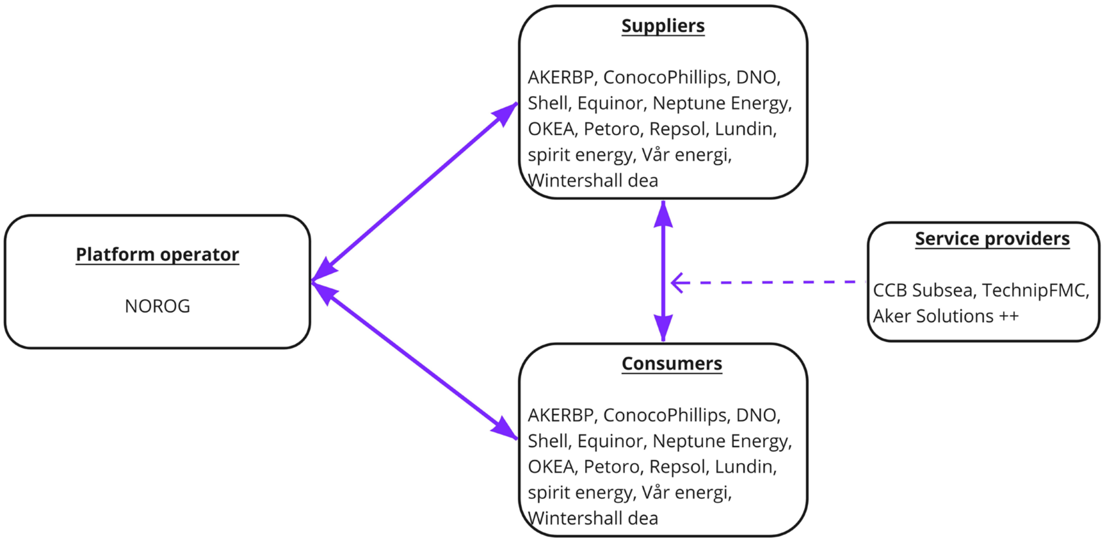

Figure 4-1: Subquip as a two-sided market

Adapted from Piscicelli, Ludden, and Cooper (2018)

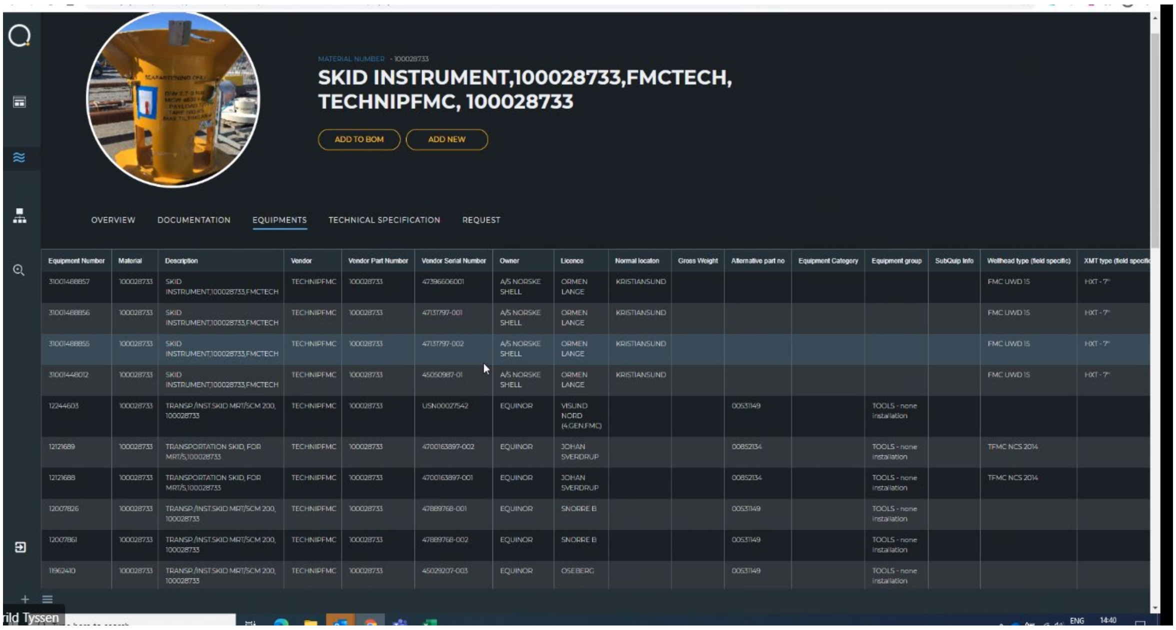

Figure 4-2: Items overview for Skid Instrument. Screenshot from Subquip Portal

The Subquip portal provides technical information about the equipment and suggested Bill of Materials (BOM) as illustrated in Figure 4-3. In addition, the users can describe how they used the equipment, which modifications they had to do, and which other components it complies with. That way, experiences with different tools and equipment can be exchanged between the users, and thus the quality of the service improves as the use increases.

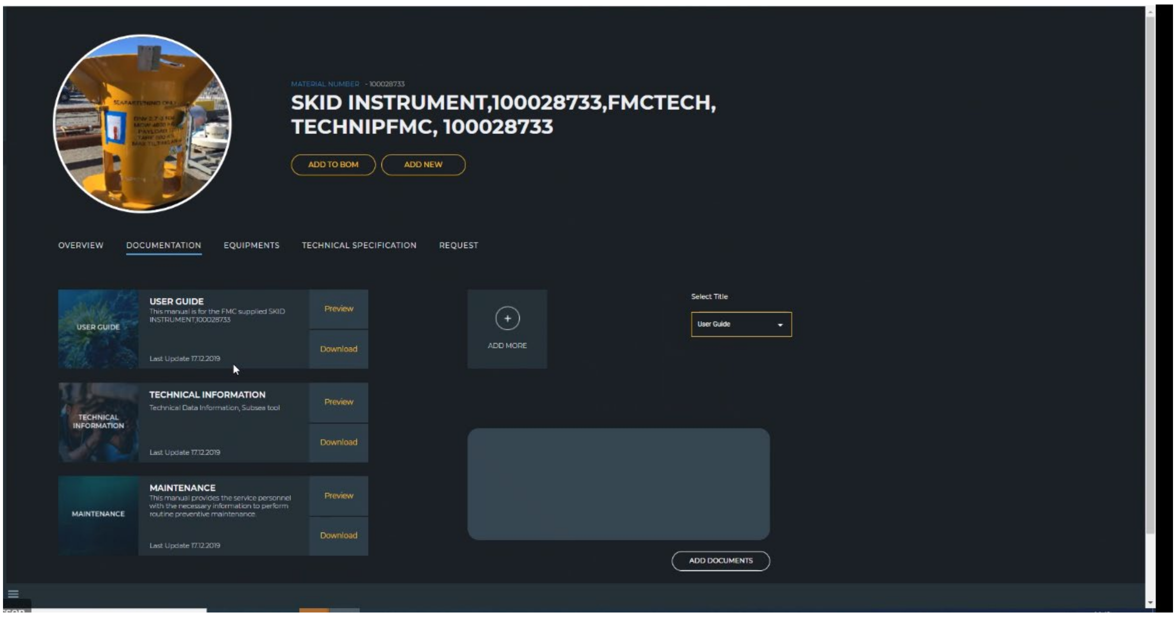

Figure 4-3: Functions in Subquip. Screenshot from Subquip Portal

4.2.2 Case companies

Norwegian Oil and Gas Association

As stated earlier, this is the industry association for companies associated with oil and gas activities on the NCS and counts over 100 member companies.

Recent years, as demanded from the members, they have intensified their work towards more collaboration across the industry, aiming to improve the overall competitiveness.

> *While the companies previously preferred to pursue their own course, they are now much more interested in standardised solutions. The association is therefore taking an active role in serving as a prime mover for such inter-company collaboration (Norsk Olje og Gass 2021).*

Their emphasis on sharing is backed up by the industry report published by KonKraft, saying that the industry must "strengthen collaboration between operators and suppliers through increased interaction, effective interfaces, reuse of solutions and experience transfer" (Konkraft 2018). This resulted in NOROG acquiring the Subquip platform, as it fit their sharing strategies well.

The representative from NOROG in this thesis is a Senior Advisor, referred to as NOROG_R1, and is responsible for the sharing initiatives run by NOROG, including Virtual Inventory which will be merged with Subquip, and EqHub, among others.

CCB Subsea

This "independent Subsea and Drilling service provider" is located at Ågotnes on the western coast of Norway. They offer subsea and drilling engineering services throughout the project phases, spanning from opportunity studies and development, to maintenance, storage, modifications etc. (CCB subsea 2021).

CCB Subsea emphasizes reuse and use of surplus materials in their services. They realised the idea of sharing subsea equipment and tools through the development of Subquip and was the owner of the sharing platform until it was acquired by NOROG in 2019.

The representative from CCB Subsea in this thesis is an Engineering Manager, referred to as CCB Subsea_R2.

Logiteam

Logiteam is a sister company with CCB Subsea and provides consultants with expertise within strategic logistics and supply chain management, especially towards the O&G industry.

The representative for Logiteam in this thesis is the CEO of the company, which has led the development of Subquip on behalf of CCB Subsea. Thus, the presented findings from the interview with Logiteam is merged with the findings from CCB Subsea, as they represent the same interests in the Subquip project. This respondent is referred to as CCB Subsea_R1.

Equinor Energy AS

Equinor Energy AS is fully owned by Equinor ASA, and is the biggest actor on the NCS, serving as operator on 213 licenses (Norwegian Petroleum 2021). As a result of this, they possess large amounts of equipment and is thus a very important actor in the sharing initiatives, and their decisions affect the whole industry.

Equinor has already been practicing sharing for many years through "Equinor Tool Pool". This is one of the barriers uncovered later in this thesis and raises questions of the existence of parallel sharing initiatives and which challenges it entails.

The representative from Equinor, referred to as Equinor Energy_R1, is at the time being lent from Equinor to NOROG, serving as Team Leader for the cooperation project in NOROG for increased competitiveness and digitalization in the industry.

ConocoPhillips

ConocoPhillips is one of the largest foreign operators on the NCS and serves as operator on 32 licenses (ConocoPhillips 2021; Norwegian Petroleum 2021).

The representative from ConocoPhillips is a Senior Contract Specialist, referred to as ConocoPhillips_R1.

OKEA

OKEA was established in 2015 as a developer and operator on smaller fields on the NCS. They are operator on 17 licenses. In 2018, they acquired participating interests in the Draugen and Gjøa fields from Shell for 4.5 billion NOK. (OKEA 2021; Norwegian Petroleum 2021)

The representative from OKEA is Principle SURF Engineer, responsible for the pipelines operated by the organisation, and responsible for equipment at the supply base in Kristiansund. The informant was involved in the development of Subquip, and its implementation into the Shell organisation at the time. The person is referred to as OKEA_R1 in this thesis.

Lundin Energy Norway

Lundin started as an exploration company but is now also a developer and an operator of oil fields. Their portfolio includes operatorship on 40 licenses on the NCS, making them the third largest in terms of number of operated licenses. Lundin was part of the development of Subquip from the beginning, together with CCB Subsea, Logiteam and Shell (Norwegian Petroleum 2021; Lundin Energy Norway 2021a; Lundin_R1 2021).

The representative from Lundin Energy Norway is Supply Manager, and referred to as Lundin_R1. The person is in charge of procurement activities in the organisation. That includes all strategic and operational contracts, procurement, and logistics.

As some insight into the organisations are provided, we move onto their experienced incentives for sharing.

4.3 RQ1: What are the incentives for sharing between companies in the oil and gas industry?

This section presents the incentives based on the different companies. Table 4-1 provides an overview of companies and incentives.

Table 4-1: Overview of incentives

Companies/ Incentives	CCB Subsea	NOROG	Equinor	ConocoPhillips	Lundin	OKEA
Risk mitigation				X		
Environmental concerns	X	X	X	X	X	
Visualise equipment					X	X
Cost savings/ economic incentives	X	X	X	X	X	X

CCB Subsea

CCB Subsea presents some main incentives for creating a sharing platform between operators. These include access to operators, gaining expertise on reuse, refurbishment, and maintenance, which will attract customers, and lastly, improved preparedness across the operators. Note that these incentives are from the point of view of the supplier side, and that Subquip originally was developed for their purposes, before NOROG came into the picture.

> *Through Subquip we have gotten an access to all operators on the NCS, we have gained access to relevant personnel. We have gained insight into what they are doing and what they are planning to do. We have experienced an opportunity to make a difficult sales job a lot easier. It*

> *gives CCB Subsea the opportunity to join more projects, because it can be done in a different way, where CCB Subsea will become a more attractive supplier than they otherwise would have been (CCB Subsea_R1).*

They experienced a demand for solutions based on reuse and sharing from operators, especially the smaller ones, motivated by cost concerns. The reason for that is because these operators often run tail production projects on existing oil fields, extending the lifetime through different operation, and margins are often lower.

> *You have an obvious motivation that is reduced costs, which is been emphasized. If the oil price drops for a week, that does not mean a lot, but now it has been low for a long time, so all calculations have been changed. It is simply harder to find fields and opportunities worth realizing (CCB Subsea_R1).*

In the process of reuse, the operators then need expertise on the adaptation of equipment, and knowledge on the compliance of different equipment.

> *The process is often as follows: they ask Subquip, can you find a christmas tree[1] And then we check if someone has that specific equipment, and which modifications must be done to adapt it, and have the dialogue with the other operator. And I think that will be the case for a long time to come as well. Maybe not on smaller items, there the platform will be "self-service", but on bigger things there will always be a service layer to some extent. These are quite complex things, and things that look very similar can be totally different. That's why it very valuable for the customers to have someone offering that service in the solution (CCB Subsea_R1).*

He further elaborates on the value proposition to the customers:

> *Value proposition is about capitalizing on acquired assets and saving costs. Either through selling them or sharing them. (…) Instead of buying*

[1] *A Christmas tree in this context refers to the assembly of valves, casing spools, and fittings used to regulate the flow of pipes in an oil well (Wikipedia 2021).*

equipment for 100 million, you can maintain your neighbour's equipment for 10, and you have saved 90 and he has earned 10 (CCB Subsea_R1).

Environmental benefits are also highlighted as an important factor:

Apart from the economic incentives, the green profile is one of the biggest motivations. (...) and it's clear that it is important in regard to the perception of the organisation outwards, but also internally actually. So environmental- and climate concerns are important, but I want to emphasize that cost reduction is the most important, an then we do good environmental actions simultaneously (CCB Subsea_R1).

Lastly, improved preparedness is an important incentive for the customers of CCB Subsea:

If this works well, the customers will, apart from saving costs, improve their preparedness because they get an actual access to equipment across the operatorships. But this is hard to see in an early phase, because most will think they will get a worse preparedness because they rent out or lend the equipment (CCB Subsea_R1).

NOROG

Being an industry association, NOROG's incentives are based on environmental gains, facilitating for collaboration among its members, which ultimately leads to cost savings across the industry.

Reuse is constantly gaining traction. Not only in this industry, but more generally, including on a personal level. The waste regime we were part of before is something that has changed with this emphasis on environmental concerns. By reusing, we create less waste compared to producing new equipment (NOROG_R1).

Regarding collaboration he states the following:

> *Our role is to secure collaboration. We are an industry association, and a neutral part without commercial ambitions in this initiative. We will only facilitate for increased sharing (NOROG_R1).*

He further says that an important part of sharing is the visualization of equipment: which also contributes to risk mitigation:

> *We will not get involved in the formal agreements between the sharing actors, we will only facilitate for the sharing through visualizing what is available. By not visualizing the equipment, you can risk production stops due to missing parts, and that costs many, many millions (NOROG_R1).*

Equinor Energy AS

The three main incentives for sharing for Equinor are the issue of sitting on too much equipment, the wish to increase utilisation, and address the environmental concerns:

> *One thing is that many experiences to be in possession of large inventories of spare equipment which, for different reasons, is not reused. That is unfortunate, because it ties up capital, in value, which you must show in your accounts, but it also involves operational costs related to storage and maintenance. So the main driver is the wish to decrease your inventory and use the things you have invested in (Equinor Energy_R1).*

In regard to environmental concerns, he states the following:

> *As an industry, you wish to appear as a more circular economy, that reuses things you own, and not a setting you perceive as use and disposal. (...) One thing is that it gives a better image, but it actually gives economy, so you can say that those things actually pull in the same direction (Equinor Energy_R1).*

ConocoPhillips

The main incentives for this company are related to decreased costs and risk mitigation. Environmental benefits come as an effect of increased utilization and agreements on standards.

Here, the emphasis is on the importance of Equinor sharing their standards. However, this is not related to Subquip directly, but shows how it impacts the market.

> *… we benefited from Equinor sharing their standards. And we know that If we show our face and our commitment that we will use the same type of standards, that actually pushes the market to efficiency, because it makes the operators more disciplined, and the suppliers knows what they shall produce. As a matter of fact one of the suppliers still saw that there were differences between the systems, and they actually produced something above the standards they had agreed, but it became cheaper because they don't have to redesign, and economies of scale are getting bigger and bigger, and cheaper and cheaper (ConocoPhillips_R1).*

They also see benefits regarding maintenance:

> *If somebody searches and finds something at ConocoPhillips, they come to us and ask if we want to loan it. And we tell them that as long as you give it as you got it, we are okay. You don't need to pay us anything, we don't care. Because our gain is that the equipment is freshly refurbished afterwards, freshly recertified, so we have something of value, and we also know that next them they will help us (ConocoPhillips_R1).*

And for the positive environmental side-effects he states:

> *… maybe the agreed standards can decrease the amount of chemicals you need to inject, or energy use. But I don't know, I don't think so. It can be beneficial in the sense that if the standards, if the operation becomes more efficient you can use less boats, less diesel and stuff. It is essentially less waste, that's where the benefits come from (ConocoPhillips_R1).*

OKEA

Cost savings and visualization of equipment are the most important incentives for OKEA.

> *Our motivation is simply how to save money and thus create profitability for the company. (…) It is profitable because we don't need to acquire that much equipment ourselves, and also rent out available equipment. There is no doubt that for us, it is about the bottom line. We are a private owned company, and ultimately, profitability is the driving force (OKEA_R1).*

On visualization:

> *The reason Subquip was made was because we had to rent out our equipment, but there was no place to display what we possessed. (…) And we had to have something that was outside of Equinor's Tool Pool. We see that it is so much pool stored around the country (OKEA_R1).*

Lundin

Lundin emphasise incentives like profitability, product life extension, visualisation, environmental concerns, and product development.

On profitability:

> *Equinor has over 100 subsea christmas trees stored on shore as reserves. They are supposed to be on the seabed and be a valve for oil production, so having them on shore is very unprofitable. (…) If you could use half of that, one could save 30-40 mNOK for each tree (Lundin_R1).*

He then explains how increased use extends the lifetime of the equipment:

> *… if you get the equipment in circulation, it is being maintained. Then it will be taken out of storage, inspected, lubricated, and be prepared. (…) What eventually makes the equipment break down, what breaks*

down your car too, is the lack of use, stored in the garage. So it extends the lifetime on the equipment by getting it into circulation (Lundin_R1).

Increased visualisation is listed as one the most important incentives:

The great advantage is first and foremost access to the overview of equipment. The immediate problem was that no one had the overview, who owned what, across operatorships (Lundin_R1).

Environmental concerns are mentioned as an emphasized motivation, stating that "Recycling and reuse was definitely an incentive, together with the customers environmental considerations" (Lundin_R1).

Lastly, Lundin emphasizes product development, saying:

You use what you already have, and that could mean slowing down development, but on the other hand it allows new development as well, because you get bigger volumes on standardized equipment (Lundin_R1).

Having presented the incentives, the barriers now follows.

4.4 RQ2: What are the barriers towards implementation of a sharing platform in such an industry?

In this section, the uncovered barriers are displayed. The different companies experience a lot of barriers, and often the same barriers. Thus, not all barriers each company highlights are described explicitly, but they are accounted for and included in Table 4-2.

Table 4-2: Barriers per company

Company	**Barriers**
CCB Subsea	Documentation, competence on reuse, regulations, purchasing procedures, traditionally low cost focus, low reward vs risk, cultural barriers, preparedness, financing, price on equipment, competing solutions, and competitors.
NOROG	Conflicting interests, standardisation, cultural barriers, specifications, financing, competing solutions, and competitors
Equinor Energy	Lead time and planning horizon, documentation, standardisation, regulations, resistance to change, different needs and specifications, standardisation vs innovation, competing solutions, competitors, and access to key personnel.
ConocoPhillips	Standardisation, equipment data issues, regulations, different needs and specifications, competing solutions, and trust.
Lundin	Competitors, lead time and planning horizon, documentation, safety concerns, standardisation, equipment data issues, regulations, purchasing procedures, resistance to change, communication barriers, lack of information, and competing solutions.
OKEA	Dependency on suppliers, competing solutions, lack of information, cultural barriers, cooperation across the supply chain, and equipment data issues.

Documentations and regulations

There is a lot of documentation following the equipment which can entail barriers:

> *There are many contract formats saying something about the documentation shall be handled, who owns it, and who it can be shared with. (…) But it is a healthy scepticism because you are depending on the right documentation to do maintenance (CCB Subsea_R1).*

Respondent 2 from CCB Subsea elaborates:

"The documentation flow is a challenge, because some of it can protected by intellectual property rights" (CCB Subsea_R2).

The documentation is often a demand from the governments. In addition to that, competition laws are something the actors must consider when it comes to sharing in the industry.

> *Today, you cannot buy equipment just to put it in Subquip and make it available for the operators. It must have been acquired through "normal" purchasing procedures, where competition is an important element. And then you can ask, can't you, as a customer, team up with your neighbour and buy equipment? To some extent, yes, but there are complicated regulations regarding what is considered a monopolistic buying behaviour (Equinor Energy_R1).*

Same issues are experienced by ConocoPhillips_R1, stating:

> *… it could be very easy for us to work like a cartel, which is illegal, discuss compensation – we give a little bit work to this one, you give a little bit work to that one etc. – and of course we are very careful not to do these kinds of things. A, they are illegal, and B, it would not benefit anyone in the long run. So fair competition is very important too (ConocoPhillips_R1).*

Preparedness

If not enough actors are willing to share, there are limited gains in preparedness: "Many actors think it's scary to lend equipment, because then they will get a worse preparedness." (CCB Subsea_R1).

This is confirmed by ConocoPhillips_R1, saying "…that's why you are buying inventory, it's because you don't trust your supplier is able to supply you, that you will be able to find it from other stuff".

Competing solutions

Subquip has been perceived as a competitor to existing sharing initiatives by some companies.

> *By some, Subquip has definitely been perceived as a competitor to the existing (Equinor) tool pool. And that may be an important barrier, that they have their traditional business model and is locked into that one. (...) It is set up such that you sign up for a pool based on the type of equipment. Then there's an annual fee to cover expenses for the owner, and Equinor runs the Tool Pool, as they are the largest operator. (CCB Subsea_R2).*

ConocoPhillips_R1 further explains why this structure is a problem:

> *What Equinor was starting to do historically was that they start generating agreements with operators about sharing and maintaining. Let us put them in one place, maintain them, get them certified. So rather than everybody renting warehouses and people, let us put it in a big warehouse. And this was purely on maintenance type of stuff. So, this is the part where Subquip at the moment has the biggest value. Because once you make this inventory visible, the other partners can also share.*

He even elaborates more stating that however in practice it doesn't work:

> *I always give this example in meetings: "I really need to use the toilet. I knock on Equinor's door and asks to use their toilet. They say that if you wanna use the toilet, you must buy a share in the house." At the moment it works like that. It is so costly that it doesn't make any sense. But of course, they have already agreed with all the operatorships they have and all the partners they have through this agreement, the only way they can share equipment is if they agree. So, in one of the last instances actually, the choice is to pay Equinor 5 mill NOK. We could buy the equipment from the suppliers for 5 mill NOK and wait a little more. But Equinor say you have to pay us 36 mill NOK, and you need to pay us until all the licenses disappear.*

He further claims that there is lots of this kind of work that doesn't work at the moment versus what happens when they have their own equipment:

…. it is in Subquip system, but we don't have a type of subsea tool pool type of agreement. So, if you really wanna use the toilet we will charge you for the toilet. Versus they're finding something in Subquip that is Equinor's. Now they need to find which toolpool owns it, then you need to contact the Equinor toolpool and say that you want to borrow this thing. And they tell you, this is our agreement. Or they will tell you, and this is one of the interesting things why it wasn't very well taught, we needed one equipment, that equipment was in one toolpool, but they wanted to commit that they will supply all our needs in case we need, which we will never, ever need. And then they say, you actually need to be member to the two toolpools. And we say that we need only one equipment now, we don't care about anything more, and they say that this is our agreement so you need to get this one. So, we say we are committed to sharing, we pay for a Subquip we don't need, just to show that we are in this together, but now we don't get equipment. Then it needs to go through the toolpool, and the toolpool says that it needs to go through Equinor management, and then you get it.

To better understand this barrier, we must understand the ownership structure of the equipment and on the licenses:

Every oil field in the North Sea consist of an operator, and then there's some partners as well, co-owners. If you take the Gullfaks field, Equinor is the operator, and then Petoro and OMV are partners (51%, 30%, and 19%, respectively (Norwegian Petroleum 2020)). The equipment purchased for Gullfaks is owned by the partners, Equinor operates it, handles it, while the other two are paying their share. (…) This Equipment is gathered in a pool, accessed by the owners – Equinor, OMV and Petoro in this case. (...) In this pool is also equipment from other Equinor-operated fields like Troll, Åsgard and Statfjord. (...) This has been a pool for Equinor operated fields (Equinor Energy_R1).

In addition to barriers related to ownership and access, there are also different needs when it comes to the equipment.

Specifications and standardization

By agreeing on more standardized equipment, the volume becomes bigger, and can benefit from economies of scale.

> *The biggest issue in all oil sectors around the world is that every company has the approach that their specifications are best. Or cheapest. Or most fit and stuff. And when you look at it this way, and when you go away from standardisation, it becomes a self-justifying prophecy (ConocoPhillips_R1).*

However, it seems most operators agree on the cost benefits of standardization, but there are still things that work against it. For example, the different needs based on the conditions of the seabed and what is extracted. That is explained by Lundin_R1:

> *That barrier is perhaps from the technical environment who wishes to design new (equipment), because they shall optimize their production. Then they must tweak the equipment to get the most out of the reservoir.*

This brings up the question on which quality level the standards should be placed on.

> *Like on the Kristin field, with over 900 bar of pressure and 200 degrees Celsius, you still need special equipment. (...) And you also want to avoid corrosion and deposits in the valves. (...) So you want to secure that you have a good enough standard, not gold plated, but not as simple that only the least complex fields can use it (Equinor Energy_R1).*

Having presented barriers on the external level, across operators, we now look at the internal challenges associated with sharing.

Internal processes and change resistance

Many informants mentioned that the traditional purchasing procedures are very incorporated, and it can be difficult to embrace a different approach.

> *The more users, the more reuse. It is a barrier to make the companies to use it, to gain momentum. That is related to established processes*

and procedures, "we've always done it this way, and then we continue to do it like that" (NOROG_R1).

CCB Subsea experienced the same:

There is a culture to run the projects in a traditional manner, have a traditional set-up with all functions, and to buy new, state-of-the-art equipment. It is a strong culture for this, and it it's a large barrier, because this "good enough", which Equinor have emphasized, hasn't sunk into organisations (CCB Subsea_R1).

Also, scepticism towards reuse can be a barrier:

Some of the resistance lies in the organisation, on the willingness to accept a "good-enough" solution based on reuse. And then there's this with safety and responsibility in the industry, that reuse is sufficiently certified, safe and secure enough (Lundin_R1).

Figure 4-4 below presents the companies with its corresponding barriers.

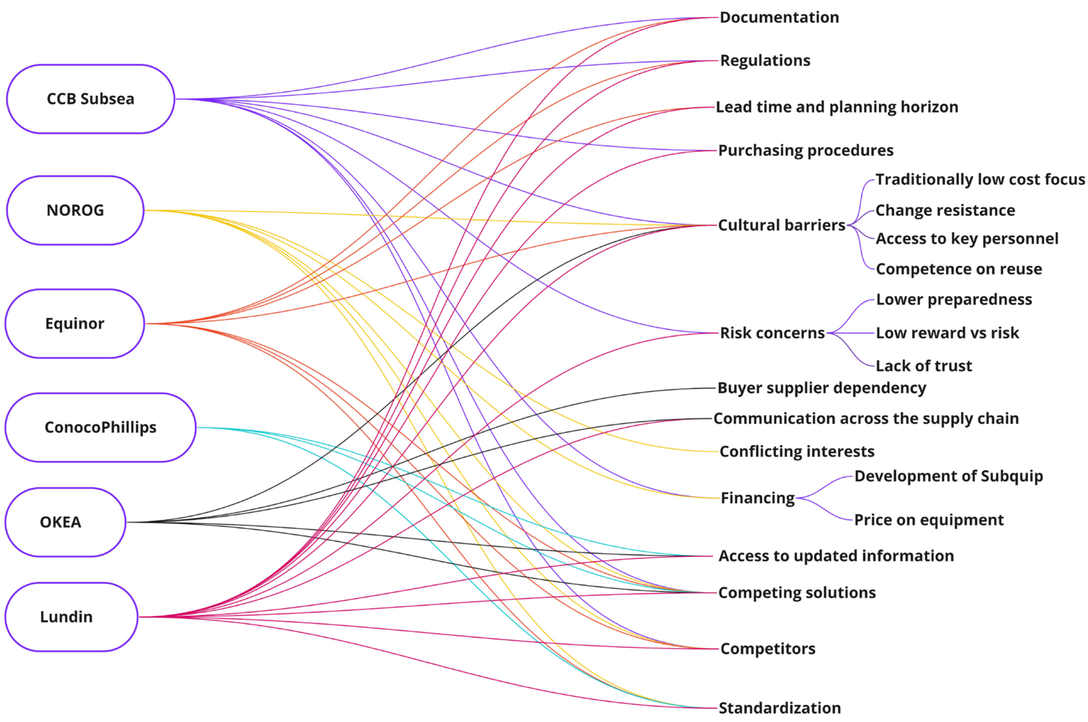

Figure 4-4: Overview of barriers

As the most important and repeating barriers are presented, we now move towards the proposed solutions to overcome the barriers.

RQ3: How can the identified barriers be overcome in order to realise the potential of a circular economy?

The following section looks at what the informants suggest in overcoming the barriers.

Documentations and regulations

Following up on barriers regarding intellectual property rights, CCB Subsea_R2 states the following:

> *This shouldn't actually be a barrier, because we don't need design data, we need operation data, operation manuals, General Arrangement Drawings, schematics and those types of things.*

For sharing solutions in general, it is a question on adapting the legal frameworks to facilitate sharing, without risking collusion.

> *There are many things to consider in a setting like this. That's why we have to take the low-hanging fruits first, do something about them. We must limit the scope, and balance very carefully regarding what the competition laws allow for (Equinor Energy_R1).*

Preparedness

On preparedness a lot depends on trust between the actors, and to the extent to which they can expect to get equipment when they need it.

> *There is a great opportunity laying ahead, for a better preparedness, by you getting a whole different access to equipment, and that might be most visible for the smaller operators which doesn't own as much themselves (CCB Subsea_R1).*

Competing solutions

Competing solutions is mostly related to the pooling of tools based on the licenses, and where there are fees to access. On the sharing between licenses Equinor Energy_R1 states the following:

> *There are many facets on how to handle things. It is the owners who has made the structure of this pool, and thus decides if anyone can share their equipment. And in that case, what it will cost. In some cases, you have succeeded, in other cases absolutely not. That is why we acknowledge that we need a set of ground rules and framework conditions. We (NOROG) have a project now to make a recommendation on this, on how to make it an operator tool pool, and how we can build upon the foundation we have had over many years. This will be presented in August.*

Specifications and standardization

The solution to the many different standards is to agree on fewer standards, but as we saw, there are many barriers to this. However, this has been worked on for years, but there is still a way to go.

> *The whole industry has agreed on what we call the 2017 standard, which everyone tries to comply to in new projects. That means it has been worked on for many years, to coordinate the standards so all suppliers get the same specification demands. That doesn't mean that you can switch a Christmas tree from Aker Solutions with one from TechnipFMC, which is two different solutions from two different suppliers, but it means that if you go to Aker Solutions, you will get the same tree, whether it is Equinor or OKEA or ConocoPhillips purchasing it. Thus, you have laid the foundation for later sharing of both spares and excess materials (Equinor Energy_R1).*

On the same issue, ConocoPhillips_R1 explains how they are working on it across organisations:

I discussed this with Equinor, and sometimes we meet about what their standards were, we were working with one supplier and wanted to get their view on the quality issues we were having. And their standards compared to ours, they were using gold. And we would never ever agree to use that one because we would think that it was so expensive. But they had their justification why they were using it, …, but if everybody agreed to those standards, probably it would cost less. And that's what they are trying to do with this JIP, it stands for Joint Industry Project. They usually do it for R&D (Research and Development) projects. There they managed operators working with valve specs to material specs and pipe sizes and stuff like that which really drives the industry costs quite a bit down.

Internal processes and change resistance

Response to how they legitimize the changes in the organisations:

There is no lack of competence, no, but with all changes there are always some challenges. Because when you are sitting on something that you perceive as well-functioning within the conditions you have, you need some convincing to see that it's smart to change it. That's why it is so important to bring those people in, so that they are heard, and their points of view are included. So, there's a double gain here. One, the individual experiences to be part of the change process, and two, you actually capture the important stuff, where the shoe pinches (Equinor Energy_R1).

He further explains that they aim to expand the planning horizon, such that Subquip can become a "first-stop-shop", where you check available sharing solutions before you tender for new equipment.

On the internal challenges Lundin_R1 explains their challenges:

Resources and cooperation across the organisation can be challenging, meaning between purchasing, engineering, and the license project. It must be lifted from a cooperation initiative directed by NOROG and get *it rooted in the technical environments in the organisation. And then you need to lift forward stories of success, that's important.*

As the findings now are presented, we move on towards to the discussion of them.

5.0 Discussion

5.1 Chapter Introduction

In this section, the uncovered incentives, barriers, and means to overcome them, will be discussed with basis in the literature provided in chapter **Feil! Fant ikke referansekilden.**.

5.2 RQ1: Incentives for sharing

First, the main incentives for CCB Subsea are discussed, as they developed the sharing model. Then, the other four uncovered incentives are covered, as seen in Figure 5-1. Table 5-1 presents the uncovered incentives compared to the existing literature provided in the thesis.

Table 5-1: Uncovered incentives compared to the literature

Uncovered incentives	**Covered in the literature by**
Capitalise on existing equipment, implementing and using a CBM (CCB Subsea)	(Lacy et al. 2014; Bocken et al. 2016; Lewandowski 2016; Frenken and Schor 2019)
Environmental concerns	(Govindan and Hasanagic 2018)
Cost savings/Economic incentives	(Benkler 2004; Piscicelli, Ludden, and Cooper 2018)
Visualisation of equipment	Not found
Risk mitigation	Not found

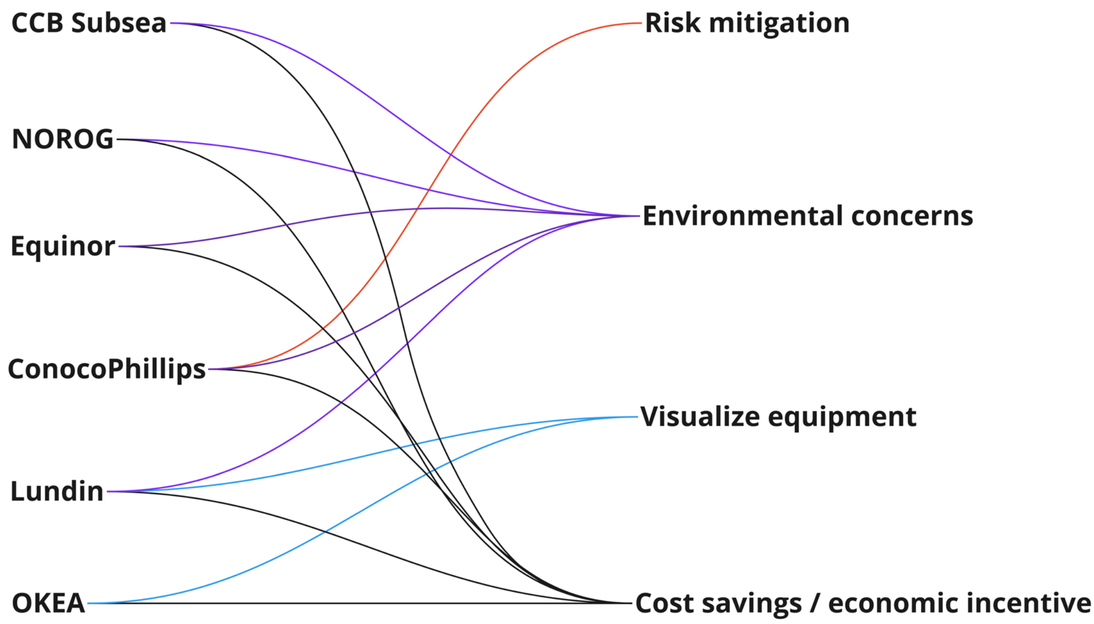

Figure 5-1: Overview of incentives

The main incentives of CCB Subsea are access to operators, gaining expertise on reuse, shared use, and maintenance, which ultimately will attract customers. In addition, they mention improved preparedness across the operators. However, that does not affect them directly, but can strengthen their position in the longer term as a service provider for sharing and reuse cases.

Figure 5-2 shows why CCB Subsea developed the sharing platform, based on their perceived market opportunities, and their competitive advantages.

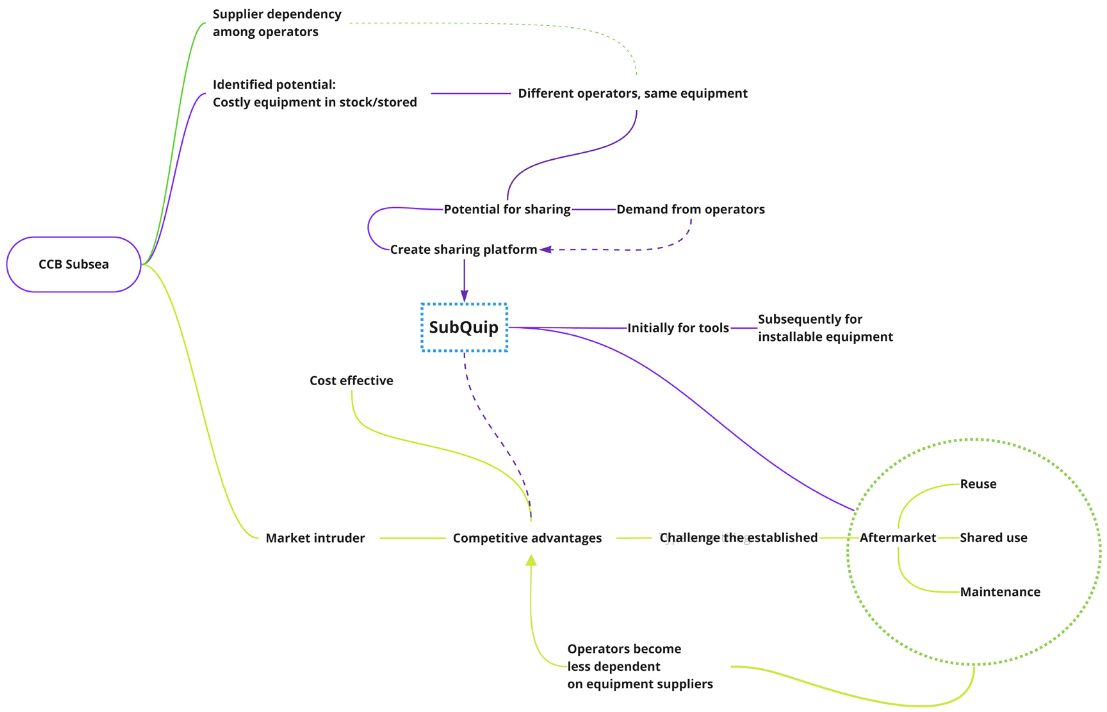

Figure 5-2: Incentives for creating Subquip

CCB Subsea creates value from materials which are already circulating in the material loop. By reusing or upgrading equipment, which in many cases would be stored until it became obsolete, they thus extend the product lifetime, and enable value capturing through the equipment's added life cycles, while saving costs from avoiding manufacturing of new equipment. This is supported by Lacy et al. (2014) and Bocken et al. (2016), describing business models based on product life extension, and recovery and recycling, respectively. This is also in line with what Lewandowski (2016) sets as premises for a CBM in general – to create, deliver, and capture value with and within closed material loops.

With regards to Subquip, its value proposition also refers to the main benefits in a sharing model: Sharing between actors in a two-sided market facilitated by a mediator (illustrated in Figure 4-1), enables higher asset utilisation, generating value through the lifecycles while saving costs, as proposed by Frenken and Schor (2019).

These environmental benefits of the sharing platform are also important incentives for the users.

Environmental concerns

Five out of six companies mention explicitly that environmental concerns incentivise for sharing. However, some of them acknowledge that it is mostly a positive side effect of economic incentives. Regardless of causality – looking at the industry as a whole – less equipment gives less demand for raw materials. Equipment is also refurbished due to a mutual gain for both owner and customer, and less materials enter the cycle. Together, these factors will slow down the material loops. Also, standardization can give an additional environmental effect, as standardized equipment with higher spec level can be applied on a wider spectre of operations, and thus lower the total volume of equipment. These findings underpin that environmental concerns are a driver for CE, as stated by Govindan and Hasanagic (2018) – production and consumption of materials, together with the amounts of waste it entails ultimately causes global warming due to its carbon emission, together with the use of raw materials it represents.

Following up on standardisation, it can simultaneously drive the unit costs down. That brings us over to the economic aspect of the sharing.

Economic incentives

All the companies highlight economic incentives as fundamental for participating in the sharing initiative. The main problems they wish to solve include the amount of capital tied up in equipment, and the low asset utilization that follows. Regarding tied up capital, the purchasing of large amounts of equipment makes a big impact. However, maintenance and storage represent large cost items as well. It seems like the companies all agree that sharing or renting, rather than ownership appears more beneficial in many cases. This is supported by Benkler (2004) saying that physical goods with excess capacity is better utilised if they are shared, rather than owned, and Piscicelli, Ludden, and Cooper (2018), highlighting the lowered transaction costs through a sharing platform compared to direct interaction between the actors.

It is also a consensus among the respondents on the importance of standardisation. It constitutes great potential for benefiting economies of scale if the industry used the same standards to a larger extent. In addition, increased standardization could result in a larger pool of compatible equipment.

The economic incentives are closely tied with the next incentive.

Visualization of equipment

Visualization serves as a precondition for sharing but is not found explicitly in the literature provided for this thesis. However, it is highlighted as an own incentive, as two out of six companies mention this. These two justified the incentive based on the current lack of overview of equipment between operators and tool pools, but also internally. By visualizing equipment in one specific place, organisations with large assets can get their equipment into circulation more easily.

If equipment is visualized, it will also affect the last incentive as well, namely risk.

Risk mitigation

The perceived risk will be affected by visualization because the customer then will have a much better foundation for planning of operations. It is an important factor in sharing, as we will see in the barrier section, that short planning horizon due to unknown availability of equipment results in a high perceived risk. A big part of the explanation for why there are large amounts of spares, is due to the risk of not getting it in time, which ultimately could lead to production stop or project delays. Based on this, risk mitigation is sorted as an incentive for visualising and sharing through Subquip. I have not succeeded to find relevant literature on risk as a driver for CBM implementation. A reason for that is because risk appears as a distinctly case specific incentive.

Now follows discussion on the next two RQs.

5.3 RQ2 and RQ3 - Barriers and means to overcome them

The following section is based around the barriers, as sorted in findings. The question of how the potential of a CE can be realised is also discussed with its corresponding barrier. That is, RQs 2 and 3 are both addressed here. Table 5-2 presents the uncovered barriers compared to existing literature provided in this thesis.

Table 5-2: Uncovered barriers compared to the literature

Uncovered barriers	Barriers from the literature	Authors
Documentations and regulations	Lack of information exchange between supply chain actors	(Vermunt et al. 2019)
	Reluctance to involve external stakeholders in CBMI activities	(Guldmann and Huulgaard 2020)
	Regulatory barriers on a market or institutional level	(Kirchherr et al. 2018; Govindan and Hasanagic 2018; Vermunt et al. 2019; Guldmann and Huulgaard 2020)
Preparedness	Not found explicitly	
	Takes time to build new partnerships and mutual trust	(Guldmann and Huulgaard 2020)
Competing solutions	Conflicting interests between actors in the supply chain	(Vermunt et al. 2019)
Specifications and standardisations	Resistance from stakeholders with vested interests in the linear economy	(Vermunt et al. 2019)
Internal processes and change resistance	Management issues	(Govindan and Hasanagic 2018)
	Hesitant company culture	(Kirchherr et al. 2018)
	Customers perceives refurbished products as lower quality	(Govindan and Hasanagic 2018)

Documentations and regulations

For the sharing in the industry, documentation can be a barrier. However, the findings show that the documentation itself is not the problem, but rather the availability of the relevant documentation. This lack of information between supply chain actors is supported by Vermunt et al. (2019), which categorise it as an external, supply chain barrier. However, it can arguably be considered as an internal barrier as well, in the category "knowledge and technology". It depends on where the bottleneck for information flow is. It was made clear that maintenance does not necessarily require the design data, only operation data, operation manuals etc. That means that the information is unavailable due to lack of communication between actors, or because relevant personnel do not have the knowledge on what kind of documentation is necessary. Anyhow, the proposed solution from the respondents was to share the relevant documentation. That, however, requires a common understanding between the actors on what this means, and a clarification of its importance.

Alternatively, as the equipment sometimes can be intellectual property rights, companies can perceive this as a risk, and thus be reluctant to share it. It is also usual for operators to rent equipment from the equipment suppliers (e.g. from TechnipFMC, Aker Solutions etc.), and that may include contracts of secrecy about the equipment. However, this rented equipment is not necessarily available in Subquip in the first place. The question about the equipment suppliers' access to Subquip is also a relevant question here, because NOROG, the owner, also represents these companies. As of today, equipment suppliers do not have directly access to the platform and was not intended to have either when it was developed by CCB Subsea. Guldmann and Huulgaard (2020) included this issue as a barrier to CBMI on value chain level, describing it as reluctancy to involve external stakeholders in CBMI activities, and the fact that it takes time to build partnerships and mutual trust.

Sharing also entails many legal issues, and the question of access for equipment suppliers is relevant here as well. As the respondent from Equinor stated, this can raise legal issues regarding competition laws, because there are issues associated with equipment put into Subquip, without going through normal purchasing procedures, and thus be perceived as monopolistic buying behaviour. In the research literature, most authors have legal barriers as an own category, as regulatory barriers on a market or institutional level (Kirchherr et al. 2018; Govindan and Hasanagic 2018; Vermunt et al. 2019; Guldmann and Huulgaard 2020). This issue is mainly up to NOROG to decide, and to adapt the sharing to the applicable legislation while avoiding collusion. The competition laws are fundamental for well-functioning markets, and collusion would only harm the industry in the long run. In addition, on governmental level, the legislature must also see the benefits of sharing and, if possible, adapt the legislation accordingly.

Preparedness

Many of the uncovered barriers are related, and thus affect each other. One barrier is not solved due to another barrier, and it sometimes becomes a question of the chicken and the egg, where one stakeholder is depending on the other to make a change or to adapt. Preparedness is no exception. As we saw, the perceived risk of low preparedness is one of the reasons as to why the companies choose to buy equipment themselves. Better preparedness is realised first when everyone agrees on the terms for sharing, increase transparency and build trust between each other. This is consistent with the barrier presented by Guldmann and Huulgaard (2020), saying that it takes time to build trust, and to some extent related to the barrier concerning unpredictable flow of returned goods. Even though trust and preparedness are connected, there is reason to claim that preparedness can be considered an own barrier. Anyhow, it can be a strength that the sharing initiative is run by NOROG, as it does not have any commercial interests other than the overall competitiveness of the industry. On the other hand, they must balance their efforts, because they also represent stakeholders, which if isolated can suffer from the initiatives. That brings us over to the next barrier, competing solutions.

Competing solutions

This barrier is mainly tied to the current structure of different tool pools for certain operators and licenses, and with different membership fees. One problem is that the stakeholders of these solutions may want to continue this, because it can benefit them and give them a competitive advantage. That is supported by Vermunt et al. (2019), pointing at conflicting interests in the supply chain. Another problem is that this membership model can prevent sharing among the whole industry. The reason for that is because even if the equipment in Equinor Subsea Tool Pool is visualized in Subquip, they require a fee to access it. The consequence can be that sharing then becomes more expensive than purchasing new equipment. Especially, as we saw for smaller, single projects, there were very little incentive to access a tool pool. Due to the annual fee that provided access to all the equipment in the Equinor Tool Pool, the total costs exceeded the costs for the single demanded tool.

It is hard to give a recommendation on what can solve this barrier. The owner of the equipment has set up the sharing structures of the existing tool pools. Thus, they are also the ones who must coordinate with NOROG, and followingly decide which solutions and compromises they can accept. The alternative is to preserve status quo, but then they must consider the risk of having to "compete" with Subquip and other sharing initiatives, and risk not getting their equipment visualized on other platforms. However, we know that NOROG has an ongoing project on this issue, which aims at recommending a set of ground rules and framework conditions.

Specifications and standardization

The nature of the industry and its operations makes fully standardized equipment impossible. However, there are many gains from agreeing on certain standards. The findings uncover that standardized equipment with higher quality and thus a wider spectre of application can be more beneficial cost-wise compared to equipment with lower quality made for single purposes.

It is a concern that the equipment suppliers could work against standardisation to some extent, as sharing and reuse can be considered a threat to their current business model. This is a barrier found in the literature as well, as many stakeholders are dependent on a linear economy to make profits, unless they adapt to the circular supply chain themselves (Vermunt et al. 2019).

Another benefit of standardization is the opportunity it provides regarding reuse of equipment in the next round. This makes a direct impact on the extension of product lifecycles, and thus the slowing of material loops. It is already a lot of emphasis towards standardization, for example the 2017 standard, as mentioned by Equinor Energy. This is an agreed standard for design and specifications for different equipment and installations in development and operation of O&G projects, and is embodied in Norwegian Standards (the organisation responsible for all standardisation areas in Norway, except for electro technology and tele communication (Standards Norway 2021b). In addition, the equipment suppliers now offer the same types of equipment and specifications regardless of the operator. That improves the ability for later sharing, and Equinor now also runs Joint Industry Projects to agree on the same standards across the industry. However, it came forward in the interviews that there was still a long way to go, and many operators were having different demands to the standards and specifications. Such technological issues are also an important barrier in the literature, but here it is not necessarily related to the quality of reuse products, but rather to its compatibility. Based on this, the existing barriers in the literature provided does not cover the same aspects as uncovered here, related to standardisation.

Besides, using standardized equipment and the benefit from the economies of scale it entails must also be measured against the value maximum oil recovery represents. If this does not add up, companies would probably choose the latter – to maximize profits. The issue of customization of equipment is thus also related to the technical environments in the organisations. This brings us over to the internal processes and change resistance.

Internal processes and change resistance

Sharing and reuse constitute new procedures in sourcing as well as in the engineering phase. NOROG experiences challenges regarding the momentum, convincing the organisations to embrace the sharing and communicate the benefits if everyone participates. CCB Subsea experienced the same when they launched Subquip. This can possibly be attributed to reluctancy among the leaders in the targeted companies, what Govindan and Hasanagic (2018, 300) categorise as *Management issues* – described as "lack of support from top management; other issues have a higher priority in enterprises and within the organisational structure" (Govindan and Hasanagic 2018, 300). Also, both NOROG and CCB Subsea highlight the issues of incorporated procedures, including the tradition for purchasing new, specialized equipment through the usual channels. This complies with a survey on barriers to CE conducted by Kirchherr et al. (2018), where 48% of the businesses point at hesitant company culture, making it the most influential barrier. It takes time to turn a large ship, and there are many influential forces within the organisations as well. Scepticism towards reuse is also mentioned, both in terms of safety and the perceived quality of the equipment, together with preparedness and challenges of longer lead times. This is backed up by the barrier literature under culture and social issues, stating "customers generally have the wrong perceptions on refurbished products and question their quality, health and safety. Hence, this lack of willingness to buy used products forces the remanufacturers to not go for refurbishing/remanufacturing" (Govindan and Hasanagic 2018, 299).

The proposed solutions are simple enough, but still hard to implement – involve the relevant people, listen to their challenges, make adaptations based on that input, and create a common understanding. However, it is a barrier to access these people, as the development and implementation of the sharing initiatives run in parallel with the day-to-day business in the organisations.

All in all, the findings uncover barriers, which are common for CE implementation. Figure 5-3 shows how the barriers fit into the categories from Govindan and Hasanagic (2018). That being said, some of the barriers are also unique for the industry even though they fit the framework. For example, there are specific barriers regarding standardization, caused by different needs in different oil fields, and legislation and market composition is unique for the country.

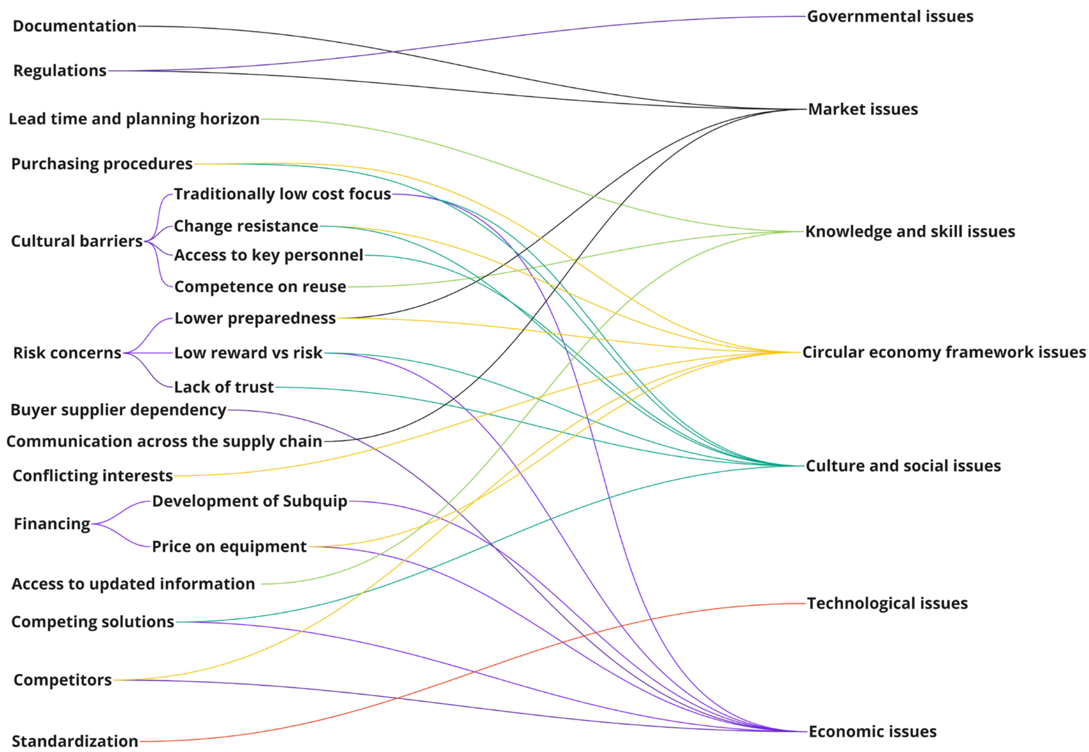

Figure 5-3: Uncovered barriers compared to categories by Govindan and Hasanagic (2018)

6.0 Conclusions

6.1 Chapter Introduction

This section sums up the findings and discussion, explains the theoretical and managerial implications, points at the limitations of the study, and suggests further research.

6.2 Research summary

This thesis has conducted a case study in the Norwegian O&G industry to uncover the incentives for sharing, which barriers it entails, and how they can be overcome to realize the potential of a CE. Seven interviews are conducted with six different companies. The sharing platform Subquip has been in the centre of the research.

Subquip fulfils the characteristics of a sharing model, as companies visualize and lend equipment between each other through the software. Regarding CE, it will slow the material loops, as the demand for raw materials will decrease proportionally with the amount of reused equipment across the industry. Lower costs and environmental benefits are also added to the value proposition towards customers that consider sharing and rental rather than purchasing new equipment. The consequence of extensive repair, reuse, and refurbishment is also an increased lifespan of the equipment, and followingly increased value.

Most of the companies that participated in this study have communicated officially that they work to minimize their impact on the environment. However, the findings show that economic incentives are the main driver, while use of less resources and increased circularity comes more as a positive side-effect. This is in line with what Govindan and Hasanagic (2018) found in their literature review on CE drivers, uncovering that companies meant that "implementing CE in supply chain could increase the long-term revenue generation through effective recycling and remanufacturing activities" (Govindan and Hasanagic 2018, 288).

Additionally, multiple barriers are uncovered in this study, mainly related to documentation and regulations, preparedness, competing solutions, specifications and standardization, internal barriers, including resistance to change. Based on the data obtained from industry companies, suggestions for how to overcome the barriers are presented, representing a management perspective.

6.3 Theoretical implications

Regarding incentives to adopt a CBM, the opportunity for the companies to visualise their equipment, making it available for others, stands out as a unique incentive for this case, compared to the literature. Same applies for the associated potential to mitigate risk due to better preparedness. This is also not found explicitly described in the literature.

On barriers, standardisation, or the lack thereof, is a barrier which is not found in the literature provided in this thesis. Different needs and specifications depend on the conditions in the oil wells and which resources they extract, but to a large extent it also depends on what the different operators and equipment suppliers emphasise, together with other organisational factors. Such factors can be the size of their license portfolio in the industry, their time horizon for the equipment, their financial capabilities, and how much they use customized, state-of-the-art equipment.

The rest of the incentives and barriers uncovered, fit the existing literature. However, the literature includes a review on the subject "barriers to CBMs" by Govindan and Hasanagic (2018), and to capture all, their categories are broad. This means that it does not necessarily capture the essence of the issues provided here, which are specific to this industry. This is mainly due to national legislation, which demands competition between the actors, existing sharing practices where a selection of companies and licenses own and share equipment internally, and due to the market structure consisting of equipment suppliers, operators and owners of the oil fields (licensees), and other service companies.

Hence, this thesis contributes with knowledge on CBM implementation in this particular industry and place the incentives and barriers into scientific terms. The results can be applicable in similar industries abroad, and in the further implementation of a CBM (Subquip) in this industry.

6.4 Managerial implications

The study finds that there is a need for a mutual understanding between the stakeholders of the importance documentation flow represent, and how commitment to sharing benefits everyone with regards to both cost savings and preparedness.

Same applies for standardization, which can unleash the potential of the CBM further, by driving the industry costs down, while extending product life cycles and enabling reuse of equipment. Thus, the stakeholders must clarify their different needs and barriers, and, within the law, agree on standards wherever possible, while considering everyone's needs.

In addition, adapting legal frameworks to facilitate sharing is necessary to fully realize the environmental and economic benefits of a CE. Sharing can constitute conflicts in terms of lack of competition, so the legal frameworks must be adapted correspondingly to avoid collusion.

6.5 Limitations of the study

This study is limited to six companies and seven informants. Naturally, this is not sufficient to cover all aspects of the incentives and barriers towards sharing in the industry, and one representative does not represent a company with hundreds of employees adequately. Also, the informants are employed by companies with commercial interests, and followingly the answers can be affected by that. In addition, despite that we limit the scope to sourcing and sharing of equipment, the whole industry is based on extracting petroleum, which itself conflicts with the main thoughts behind CE. Thus, the sustainability term is excluded or used with reservation. Lastly, this thesis having a qualitative approach, it cannot determine the effects of the sharing quantitatively, other than what the informants state.

6.6 Further research

Following up on the limitations on a qualitative approach, it is of interest to measure the performance of the CBM. For example, the amount of sharing, and its environmental or economic impact compared to a linear business model.

Each of the barriers can also form the basis for further research, as this research only uncovered them, without diving into them thoroughly.

Lastly, the practice and logistics associated with maintenance, refurbishment, and reuse in the industry is of interest to map and optimize, which can accelerate the CE further.

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8.0 Appendix

8.1 Appendix 1: Interview request

Hello.

I study Logistics and Supply Chain Management at Molde University College, and writes a master thesis about SubQuip. The main focus in the thesis is to uncover barriers associated with implementation and use of the sharing platform, based on literature from sharing economy and circular economy.

The following research questions are presented in the thesis:

RQ1: What are the incentives for sharing between companies in the oil and gas industry?

RQ2: What are the barriers towards implementation of a sharing platform in such an industry?

RQ3: How can the identified barriers be overcome in order to realise the potential of a circular economy?

I have already interviewed xxx from Norsk Olje og Gass, representatives from the developers of the platform, and CCB Subsea. In addition, I would like to capture the perspectives and experiences from the operators on the NCS who uses SubQuip.

Thus, I wonder if I can conduct an interview with you, or another relevant representative from your company. The interview will last for about 45-60 minutes.

Hope this can seem interesting for you.

Regards
Henning Liseth Langedal

8.2 Appendix 2: Interview guide

Interview guide

Name: Date: Position/role:

General

1. What is your position in [company]
2. Short about [company] and their role in relation to Subquip and CCB Subsea
3. Short about your role in relation to Subquip

Subquip in general

4. What is Subquip
    a. Is it in use?
    b. What is shared in the platform?
    c. Are contracts and transactions completed through the platform?
    d. Who developed the platform?
    e. Who owns and run it?
    f. What are potential customers and suppliers?
    g. Are there competition between the participants in the sharing platform?
        i. Elaborate
5. What is the role of CCB Subsea in the sharing platform?
    a. What is the value proposition?
    b. How do you generate revenue?
    c. What are the cost driver(s) in the platform?
6. Briefly, how is the process from customer request, until the product or service is provided?

RQ1 Motivations/incentives

7. Subquip represents an alternative to traditional purchasing procedures. Which motivation is the development of the sharing platform based on?
    a. Political guidelines, laws or regulations?
    b. Profitability for the company?
    c. Health and/or resource use?
    d. Environmental or climate concerns?
    e. Social concerns (e.g. employment)?
        i. Customers environmental concerns/demands?
    f. Was there a need for/does it create product development?
    g. Advanced digital technologies?
    h. Other motivations?

8. Which advantages does Subquip give you?
    a. Can you mention your customers?

9. Which advantages does Subquip give your customers?

10. Compared to a traditional process, is it a noticeably less need for new equipment?

11. To which extent does Subquip extend the products life cycles?

12. To which extent would you say that Subquip takes over for traditional processes?
    a. Have you changed your business model, or is the sharing platform more as a contribution to traditional processes?

<u>RQ2 Barriers against implementation / RQ3 How to overcome the barriers? (Combine these)</u>

13. A sharing platform is often dependent on a substantial amount of users. Which significance does this network effect represent in Subquip?
    a. Is the amount of users a constraint today?
    b. If so, do you have a plan to solve it?

14. When developing and using the sharing platform, which barriers have you encountered?

    Examples:

    <u>Market</u>

    a. Regulations
        i. Quality assurance/certification
    b. Financing
    c. Uncertain market demand
    d. Price on new equipment is competitive with reuse
    e. Others?

    <u>Supply chain</u>

    f. Transition from a traditional solution to sharing (changed supply chain)
    g. Did it require change in infrastructure or large investments you and your customers?
    h. Quality on the equipment/materials
        i. Standardisation
        ii. Does it require much adaptation/many workhours?
    i. Lack of, or unpredictable access to equipment/materials
    j. Complex supply chains
    k. Scepticism among customers and suppliers?

i. Secrecy/patented technology
ii. Are customers tied/dependent on their suppliers?
iii. Lack of competence among customers or suppliers
iv. Level of vertical integration

l. Others?

Organisation

m. Limited emphasis on sustainability?
n. Scepticism among the management of the company?
o. Too low profit compared to existing business model / too low return on investment?
p. Fear of cannibalisation?
q. Lack of resources?
r. Cooperation across the organisation?
s. Others?

Employees

t. Lack of competence?
u. Change resistance?
v. Difficulties communicating the idea behind a new business model?
w. Are there incentives working against increased sharing?
x. Others?

Lastly:

I hope to interview more customers or suppliers of Subquip. Can I ask if you have any relevant people I could contact for an interview?

8.3 Appendix 3: Schedule

Month	December						January				February				March				April				May				June				
Week	48	49	50	51	52	53	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Task																															
Proposal presentation			■																												
Review feedback			■																												
Write literature review				■	■	■	■	■	■	■																					
Receive feedback and adjust											■	■																			
Create overview of case company											■																				
Identify possible barriers											■																				
Data collection																															
Outline required data												■																			
Decide interviewees													■																		
Make appointments													■																		
Write interview guides														■																	
Conduct interviews															■	■															
Data analysis																	■	■	■												
Write analysis and discussion																				■	■										
Write methodology								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■									
Deliver final draft																						■									
Review feedback and edit thesis																						■	■	■	■						
Hand in thesis																										■					
Thesis presentation																											■				