Master’s degree thesis

LOG953 Sustainable Energy Logistics

Circular economy implications on sustainable supply chain management: a case study within the Norwegian fish farming industry: a single-case study

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Thank you Danielle!

In loving memory of my sister.

"If I know what love is, it's because of you. Thankyou!"

Thank you Molde University!

and

Thank you people of Norway!

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ABSTRACT

Although sustainability has long been a central concern in the operations of Norwegian fish farms, there is a growing realization that the use of circular economy principles can also improve their supply chain management. Although previous studies have focused on the link between the circular economy and sustainability, not much has been done to examine how they can be integrated into the supply chain of fish farming.

Many scholars have increased their focus on sustainable supply chain management (SSCM), while a circular economy has been established as part of environmental sustainability, focusing on three principles: reduction, reuse, and recycling. The goal of this master's thesis is to investigate how circular economy principles help to the long-term growth of SCM. This master thesis research a single case study approach. The empirical study describes a Norwegian fish farm located on Smøla island that used circular economy ideas to existing fish growing and production practices, as well as (SCM). Interviews were conducted with four individuals, and secondary data sources included company reports, the official website, and personal observations.

This master's thesis also investigates various aspects of sustainability, circular economy (CE) principles implementation, main obstacles, and implications for sustainability in the Norwegian fish farming business. The research investigates sustainable practises and transition enablers through case studies. The findings emphasise the value of teamwork, government backing, and technological adoption in achieving sustainability. High costs of technology deployment and adequate control of unwanted outputs are among the challenges. Implementing CE standards helps to optimise resources, keep the environment clean, and produce high-quality products. Long-term sustainability perspective The report provides fish farmers with practical advice, emphasising effective communication, technology adoption, and CE initiatives.

Keywords: *Sustainable SCM, Circular Economy, Value Creating Activities, Norwegian fish farming industry, Case Study, Content Analysis.*

TERMS AND DEFINITIONS:

Supply Chain Management: *"supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements" (Levi et al, 2003: p.1).*

Sustainability: *"The meaning of the term is strongly dependent on the context in which it is applied and on whether its use is based on a social, economic, or ecological perspective, sustainability may be defined broadly or narrowly, but a useful definition must specify explicitly the context as well as the temporal and spatial scales being considered* (Brown, Hanson, Liverman and Merideth, 1987), (WCED, 1987).

Circular Economy: *"A circular economy is an industrial system that is restorative or regenerative by intention and design. It 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 for the elimination of waste through the superior design of materials, products, systems, and, within this, business models." (Ellen MacArthur Foundation, 2012)*

List of Tables

List of Figures

Table of Contents

APPENDIXES

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

This chapter begins with the background information for the research in order to provide a concise summary of the study. Subsequently, the general goal and study questions were presented. Lastly, a comprehensive overview of the organizational framework of this master's thesis is provided.

1.1. Baground For the Research

The circular economy (CE) represents a theoretical concept that aims at creating an industrial system where products and services are traded in closed loops or “cycles.” The idea is to reduce the negative impact on the world by moving away from the traditional “linear” economic model for production and consumption, also described as a “take, make and dispose” model (Patrizia Ghisellini, Catia Cialani, Sergio Ulgiati, 2016). The CE is characterized as an economy that is regenerative by design, with the aim to retain as much value as possible of products, parts, and materials (Ellen MacArthur Foundation, 2013) The aim is to create a system that allows for the long life, effective reuse, refurbishment, remanufacturing and recycling of products and materials (Bocken, Schuit and Kraaijenhagen, 2018), which requires changing consumption patterns, and creating new business models and systems (Valerio Elia, Maria Grazia Gnoni, Fabiana Tornese, 2017). Previous research has suggested that CE origins are mainly rooted in the ecological and environmental economics, and industrial ecology (Ghisellini, Patrizia, Catia Cialani, and Sergio Ulgiati, 2016), and that the concept has primarily evolved as research on waste generation, resource use and environmental impact (Lieder, Michael, and Amir Rashid, 2016). Thus, the majority of existing literature on CE has a high focus on the environmental aspect (Dao, Viet, Ian Langella, and Jerry Carbo, 2011).

Therefore, it has become crucial to investigate how environmental sustainability limits might be pushed further by aligning sustainable supply chain strategies with circular economy concepts. While the concept of a "circular economy" has gained popularity in recent years, it has been criticized for focusing too narrowly on the movement's central concern material flows in economic systems to the exclusion of other important issues, such as the resolution

of environmental impacts related to energy consumption and carbon emissions (Geissdoerfer et al. 2017, Ünal, Enes, and Jing Shao, 2017., 2019)

The question of whether CE can support sustainability's environmental component or if it is a component of sustainability itself is still up for dispute. Numerous earlier studies have highlighted how CE pushes the boundaries of environmental sustainability by focusing on the concept of altering products in a way that makes viable connections between ecological systems and economic growth. It is inferred that CE is more concerned with the development of self-sustaining production systems where resources are reused repeatedly than it is with reducing the use of the environment as a sink of residuals, as is the case with sustainable supply chain (SSC) initiatives (Genovese et al, 2017). Earth's resources are few and restricted, and the rate at which they are being extracted, processed, manufactured, and used to satisfy humanity's never-ending requirements is concerning (Jawahir, I. S., and Ryan Bradley, 2008). To achieve sustainable development goals, the CE is therefore frequently regarded as a subfield of sustainability science (Geissdoerfer et al. 2017, Ünal, Enes, and Jing Shao, 2017., 2019)

This master's thesis provides an actual case study of a fish farm situated on the Norwegian island of Smøla. Since 1970, the chosen fish farm has successfully integrated circular economy principles into its fish cultivation and production procedures, resulting in a total transformation of the previous practices.

The primary objective of this master's thesis is to achieve its research objectives by investigating five research questions:

This master's thesis consists of a total of six chapters and is organised as follows:

1.2. Overall Purpose and Research Questions

The goal of this master thesis is to examine how the principles of circular economy can contribute to sustainable development of the supply chain management in a single case involving a Norwegian fish farm. The case farm, which is located on the island of Smøla. The supply chain, sustainability and circular economy and the environmental impact of fish farming are the factors that have been considered when it comes to the development of this

master thesis. The empirical case study helps to identify the main objective of the study and the various research questions that need to be answered.

Research question 1. ***How is SCM organized within the Norwegian fish farming industry***

The Norwegian fish supply chain is composed of various steps, such as the feed, broodstock, processing, retail, and farming. Each of these steps has its own specific food safety hazards that need to be monitored in order to maintain the quality of the product.

Research question 2. ***How does live fish handling contribute to making supply chain operations sustainable? is connected to sustainable practices?***

Preserving fish being alive during so many diff. operations within Norwegian fish farming industry is a core principle of how SCM can be sustainable.

Research question 3. ***What challenges do fish farming companies face under their supply chain operations ?***

There are multiple challenges associated with supply chain of fish farming sector which causes poor management of fisheries and unsustainable practices such as incentives of perverse, traceability lack and transparency issues

Research question 4. How CE principles contribute to (trade off) all the three aspects of sustainability – economic, environmental and social?

The circular economy plays its role in development reduction as well as circulation of the natural resources. So, sustainable solutions depend upon business strategies and policy development. Moreover, CE shifts *the undesirable burden by reduction of consumption of material leading to the increment of economic, social and environmental impacts*.

The goal of this study: is to explore the effects of the Circular economy implications on sustainable supply chain management: a case study within the Norwegian fish farming industry: This is done through a single case study that focuses on the importance of ensuring that the fish are treated properly during their growth phase. The sustainable practices of fish

farming can help address environmental, economic, and social issues. This can be achieved through the use of a variety of strategies, such as recycling and reusing materials, collaborating with different groups, and optimizing inputs. Through the use of digital tools, sustainable practices can be improved in Norway's fish farming industry. Communities and individuals can help the sector transition to a more sustainable way of doing business. But, this can only be done with a long-term perspective since there are no shortcuts that can guarantee quick results.

1.3. Structure of the Thesis

This master's thesis consists of a total of six chapters and is organized as follows:

- *Chapter one – Introduction*

The chapter provides an overview of the background of the master thesis, explores the necessity of narrowing the gap, and examines the rationale behind it. It also explores the viewpoints that can be utilized to analyze the scope of the study. The structure of the thesis is analyzed.

- *Chapter two – Literature review*

In this chapter, the theoretical background will connect the research with existing theory and knowledge needed to answer the research questions. Three main topics and concepts were identified from the literature to be crucial for the analysis, discussion and conclusion. Firstly, the author present the components of supply chain management second sustainability and the various aspects of the sustainbility and lastly the circular economy and the various aspects of circular economy.

- *Chapter three - Methodology*

Intorduces the research approach used in this master's thesis. It explains why the data was collected in the first place.

- *Chapter four – Results*

This chapter provides a brief review of the history of fish farming in Norway. The empirical data are then presented in accordance with the four research questions of this master's thesis.

- *Chapter five – Discussion*

This chapter will discuss how circular economy principles in the selected fish farms have contributed to the environmental and social aspects of sustainability. It will also discuss the practise of the fish farm operation and SCM and the production process, as well as some of the challenges within the production process and operation.

- *Chapter six – Conclusion*

The key research findings and research questions are provided in this chapter.

- *Chapter seven – Conclusion*

finishes the master thesis with consequences on both theory and practise, and an overview of the master thesis. It also discusses limitations and possible future study.

CHAPTER 2
THEORETICAL FRAMEWORK

2.0. THEORETICAL FRAMEWORK

2.1. Supply Chain

A supply chain is a network of numerous entities that includes manufacturers, retailers, distributors, and suppliers. It can be described as a combination of these groups that moves raw materials, produces finished goods, and manages the work-in-process inventory of its members. (David Simchi-Levi, P. K., & Edith Simchi-Levi, 2004). According to Mentzer ((2001), the term *"supply chain" can be defined as "a set of three or more companies directly linked by one or more of the upstream and downstream flows of products, services, finances, and information from a source to customer."*

A general representation of the supply chain can be made based on the definitions given below:

In addition, Mentzer (2001) categorized the various types of supply chains into four categories. These include an "extended supply chain," a "basic supply chain," a "partnership," and a "ultimate supply chain."

The extended supply chain: While the concept of the supply chain focuses on the primary components, such as the suppliers, the extended framework also includes the customers and the immediate suppliers. These entities are connected by the various flows of information, services, and finances.

The basic supply chain: The term basic supply chain refers to a central firm that is connected to an immediate client and supplier. It also involves moving products, services, and data both upstream and downstream.

A Partnership: A partnership is different from the typical supply chain, which only consists of a buyer and a supplier without any upstream or downstream connections.

The ultimate supply chain: is a network that includes the various organizations that are involved in the movement of information, services, and products. It spans the entire supply chain from the initial source to the end customer.

2.1.1. Supply Chain Management

Although the term supply chain management can be described in various ways, the concept itself has a broad understanding. It involves the coordination of various activities across multiple stakeholder groups, including those related to logistics management.

According to the definition provided by David Simchi-Levi, P. K., and Edith Simchi-Levi (2004), supply chain management can be characterized as:
"a set of approaches used to efficiently integrate suppliers, manufacturers, warehouses, and stores so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time in order to minimize system wide costs while satisfying service-level requirements."

According to Tang (2011), the concept of supply chain management can be defined as:
''the management of material, information and financial flows through a network of organizations (i.e., suppliers, manufacturers, logistics providers, wholesalers/distributors, retailers) that aims to produce and deliver products or services for the consumers".

2.2. Sustainability

2.2.1. Definition Of Sustainability

Sustainability has gained widespread interest in academic circles due to its various aspects. Unfortunately, this concept has been used to describe a vast range of phenomena, diluting its original impact and significance. Brown et al. (1987) conducted a study. There are various sustainable concepts and objects out there. Despite its widespread appeal, there is still skepticism about its definition, origins, and practical implications when it comes to implementing and developing sustainable projects. (Mensah and Casadevall, 2019).

According to Finkbeiner et al (2010), Extensive literature reviews provide valuable insight into the various factors that affect sustainability, as well as the numerous steps that can be taken to achieve it. The term sustainability has been employed in numerous academic disciplines. (Finkbeiner, Schau, Lehmann and Traverso, 2010).

"The meaning of the term is strongly dependent on the context in which it is applied and on whether its use is based on a social, economic, or ecological perspective, sustainability may be defined broadly or narrowly, but a useful definition must specify explicitly the context as well as the temporal and spatial scales being considered (Brown, Hanson, Liverman and Merideth, 1987), (WCED, 1987).

The experts from different fields, who are part of the National Risk Management Research Laboratory of the United States Environmental Protection Agency (EPA), stated that sustainability involves improving and preserving the social and material circumstances that are beneficial to the environment and human well-being. It should also ensure that these efforts do not go beyond the ecological capacities of the people and the planet (Sikdar, 2003).

The utilization of the term "sustainability" is a fundamental component of the development of public policies and business strategies. In (2010), Finkbeiner et al., noted that implementing sustainability is the most challenging aspect for many organizations. In 1998, Elkington noted that sustainability has a higher value when it comes to the three dimensions of the "3P's" - people, planet, and profit. The Cambridge Dictionary defines sustainability as the ability to endure an extended period of time while also being able to avoid or minimize environmental damage. (Cambridge Dictionary. n.d.).

2.2.2. Sustainable Development

Sustainable development is a concept that has been associated with various interpretations and implications during the discussion of development. It stems from the combination of "development" and "sustainable." Despite being broad-based, the concept has also been subject of varying interpretations. In the context of sustainable development, the most common and widely cited definition of the idea is put out by the Brundtland Commission Report (Schaefer and Crane, 2005), (Lélé, 1991). and (Stoddart et al., 2011).

In 1987, the World Commission on Environment and Development (WCED), led by former Norwegian Prime Minister Gro Brundtland, established the term: *"a development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED, 1987).

The three dimensions of Brundtland are included in its definition. These include the environment, social, and economic aspects. In (2010) Finkbeiner et al., proposed that these dimensions should be included in the revised description. The concept of sustainable development refers to the process of addressing the needs of today's generation while safeguarding the future's capability to meet them. If Earth's resources continue to be depleted, it's crucial that we take immediate action to address this matter. This is necessary to deal with the inevitable issues that will arise with the planet's population growing (Sikdar, 2003). The impact can manifest in either a negative or positive manner. The former refers to the undesirable outcome that we seek to prevent, while the latter can be linked to human pressure's effect on science and technology. These advancements have allowed us to achieve remarkable energy efficiency and material productivity gains (Sikdar, Sengupta and Mukherjee,, 2016). The concept of sustainable development continues to gain significance due to the continuous increase in the population and the scarcity of natural resources. Decision-making procedures that involve the involvement of various social, economic, and environmental concerns can help manage complicated situations. Nevertheless, this concept is often used interchangeably with sustainable development. (Sikdar, 2003). According to Diesendorf (2000), sustainable development is the goal of the whole process. In other words, it refers to the complete course of action that can be taken to achieve sustainability.

2.2.3. The Evolution of Sustainable Development

During the 1960s, the concept of sustainability began to emerge. It was primarily focused on advocating for policies that can be achieved *"the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy"* (OECD, n.d.).

The concept of sustainability has gained more prominence over time. In addition to being adopted more widely, the triple bottom line approach also includes the social, economic, and environmental dimensions of the sustainable development trend. This was the main reason for the Brundtland commission's recommendation to adopt this framework. The concept of sustainable development was identified by the Brundtland commission as a vital part of the global community's efforts to improve the quality of life for all people (WCED, 1987). To achieve this, the report proposed a series of development strategies that aim to establish an international alliance of nations that share a common set of goals known as the SDGs. The report noted that sustainable development requires raising awareness, identifying global challenges, and coming up with solutions. Bugge (2002) has riticized the report, claiming that it was too broad and lacked clarity. A year later, Gro Harlem Brundtlander, the report's assistant, stated that it was still inspiring and consistent." I advise everyone to do it » (Bugge, 2002).

The Rio Earth Summit, which was organized by the UN Convention on Industrial Development (UNCED) in 1992, was significantly affected by the Brundtlands Report. This report prompted Member States to work together to develop Agenda 21. According to Cameron, Metternicht, and Wiedmann (2018) that sustainable growth should be prioritized on the summit's agenda. They suggested the creation of innovative plans that would integrate the economic, social, and environmental dimensions of SD.

The Rio+20 conference was held in 2002, and it was focused on assessing the progress that was made in implementing the resolutions that were adopted at the Rio Earth Summit. A plan of implementation was established for the activities outlined in Agenda 21, known as the Johannesburg Plan.

The reports from UNCED after Rio+10 states that:

"we assume a collective responsibility to advance and strengthen the interdependent and mutually reinforcing pillars of sustainable development – economic development, social development and environmental protection – at the local, national, regional and global levels"

(United Nations, 2002).

The Rio+20, which was an international event that took place in 2012, was a significant event that resulted in the creation of the "Future We Want," a document that laid out a comprehensive set of strategies for the sustainable development of the world. The term sustainable development was used 238 times in the document's 49-page spread (Mensah and Casadevall, 2019). The report focused on two main themes: the green economy and the institutional framework (Cameron et al., 2018). Following the Rio+20, a new framework was established to develop goals for sustainable development, which became operative in 2015. These objectives were focused on addressing issues related to all sectors of the international development agenda (United Nations, 2012). In 2015, the UN held a conference in New York to officially adopt the 2030 Agenda for sustainable development. All of the member states of the organization agreed on the objective. It included 17 goals. The new agenda calls for collective action to ensure that all individuals are included in the process of development. It aims to tackle five key issues namely, peace, people, planet, prosperity, and partnership (United Nations, 2015).

The goal of the Sustainable Development Goals (SDG) is to help both the Earth and humanity make progress toward a more sustainable future. The plan, which is expected to be accomplished by the year 2030 and is regarded as the most efficient way to tackle the various challenges that face the world, has 169 sub-goalses. The SDG require all countries to get involved and contribute to the development of a more sustainable world. It also provides a global framework for companies, governments, and civil society to work together to promote economic growth while protecting the environment (FN, 2020), (United Nations, 2015). There is a wide range of doubts about the program's implementation, especially regarding its ability to deliver on its promises. It is therefore crucial that both the public and policymakers acknowledge that the goals and actions of the 2030 Agenda are still achievable. In response to this, the UN has urged for a more ambitious and expedited approach to the implementation of the program (United Nations, 2019).

2.2.4. Relationship Between Economic, Environment and Social Well-Being

Sustainable development is a concept that involves the various components of an economy, society, and the environment. It has three main disciplinary dimensions: the environment, the economy, and social. The pillars have also been targeted for being too "isolated" (Boström, 2012), "difficult to measure" (Lehtonen, 2004), "vague and broad" (Griessler and Littig, 2005), and "not containing enough information" (Parris, Leiserowitz and Kates, 2005). The concept of the three pillars has been presented as a framework for sustainable development. It aims to meet the needs of the present and the future generations. (Dyllick and Hockerts, 2002). In a model presented by Gauntlett and Barron in Barron and Gauntlett (2002), the three pillars are represented by interlocking circles. It is widely believed that the concept of sustainable development is placed at the center of the intersection of society, the economy, and the environment. Although many people support the concept of the three pillars, there are still disagreements about their significance. For instance, the closure of a coalmine could have a significant social and economic impact on a region. (Kjørstad, 2020).

Researchers believe that the social pillar also includes various aspects such as cultural knowledge, social solidarity, and recreational opportunities. (Parris, Leiserowitz, & Kates, 2005). Other researchers stated that the various pillars should be evaluated interactively. They also suggested that more than three should be included. (Griessler and Littig, 2005) (Boström, 2012). For example, (Griessler and Littig, 2005), noted that the three pillars do not meet the needs of society. They suggested that they should be expanded to include cultural, aesthetic, and political-institutional elements. (Burford et al., 2013), also contribute to the cultural pillar. Elkington (Elkington, 1998), who invented the term "triple bottom line" of "People, Planet, Profit," is another example. Later referred to as 3P S, TBL or 3BL.

The concept of sustainable development was presented by the UN through its 5Ps framework, which was based on the three pillars. The addition of two crucial pillars, namely Peace and Partnership, gave it a deeper meaning.The 5Ps framework was expanded to include the following: People, Prosperity, Planet, Peace, and Partnership. Its fourth and fifth pillars highlight the essential ethical elements that are required for all countries to achieve the Sustainable Development Agenda 2030. (Brown and Rasmussen, 2019). The

Organization for Economic Cooperation and Development's (OECD) theme, which is entitled "Investing in the future: people, planet, and prosperity," has also been adjusted to better describe the concept. Although the word "prosprosperity" is similar to Elkington's "profit," the Ps have been kept simpler.

The concept of sustainable growth is based on three pillars. However, it can also serve as a five-dimension model that can be utilized to deal with different real-world issues. Everything that we do on the planet affects the economy, environment, and society. The advantages of preserving natural resources, maintaining a resilient economy, and addressing conflicts depend on the respect for human rights and peace. (Jari, Ontto, Vehmas and Luukkanen, 2013).

2.3. Sustainable Supply Chain Management

The concept of sustainability was first introduced in management literature during the 1990s. It has since gained widespread popularity among policymakers and the press. A sustainable society is a framework that aims to meet the needs and expectations of the present while ensuring that the future generations can meet their own needs (Linton, Klassen, and Jayaraman , 2007). Without external support, a sustainable society would not be able to function properly. This is why the activities of the SC depend on the contributions of various external factors (Dyllick and Hockerts, 2002). Investments, sales revenue, and the like are some of the financial resources that companies need. They also require environmental resources, such as energy and raw materials, and social resources, such as workers' time and infrastructure (Savitz and Weber, 2014). Due to the importance of maintaining a healthy environment, the concept of sustainability has gained widespread attention (Abbasi and Maisam, 2012). Although the concept of sustainability has gained widespread attention, it should not be considered an add-on to the already existing framework of SCM. In (2013), Winter and Knemeyer noted that the field has a natural connection with the concept. Two related concepts are the GSCM and SSCM, which both provide a framework that focuses on the coordination and flow of SCM (Ahi and Searcy , 2013). One of the main factors that has gained widespread attention is the shift toward a more integrated approach to the SC (Linton, Klassen, and Jayaraman , 2007).

Sustainability can help companies conduct their operations more effectively due to the increasing dependency on the natural environment and the development of their SCM area. In their book, Weber and Savitz (2014), talk about the various ways that sustainability can enhance a company's operations. Being able to protect the interests of employees and communities while also mitigating risk is one of the most important factors that can be considered when it comes to implementing sustainability. Running can help companies improve their efficiency and reduce their costs. A company's focus on sustainability can help it expand its market reach, launch new services, and improve customer loyalty and satisfaction. (Savitz and Weber, 2014).

The Sustainable Communities (SCs) are made more sustainable by various challenges. One of these is the complexity of the structures and processes that are involved in their creation. For instance, the rise of economic growth has led to an increase in the distribution and transportation of goods and services. There are various examples of how complexity can arise due to the flow of free trade, shorter product lifecycles, increased outsourcing due to larger distances between consumption and production, and the scope of products changing because of economies of scale (Abbasi 2012, Morana 2013).

2.4. Introduction to Circular Economy

Due to the increasing complexity of the global economy, and the lack of a comprehensive understanding of consumption and production, traditional linear models are not able to properly account for the changes taking place. This allows for the loss of the product's embodied value at the end of its life. (McDonough and Braungart 2010, Sundin and Lee 2012). Linear production models rely on high levels of resource input to meet current demand. This leads to negative environmental consequences, including waste generation, water consumption, and emissions. (World Economic Forum, and Ellen MacArthur Foundation, 2014). It has become clear that the take-make-dispose industrial production methods are not compatible with the level of development that global communities desire.

Due to the lack of product reuse and material recycling, the demand for raw materials is expected to increase significantly (UNEP 2011, 2014, 2016a). While increased production

can result in favorable labor market conditions and economic growth, it can also lead to higher consumption of fuels and raw materials, as well as environmental degradation caused by transportation and extraction activities (UNEP 2011, 2016a). Sustainable economic systems are the objective for the long-term. (United Nations, 2018). Although economic growth is a central component of national strategies and objectives in the short term, sustainable economic systems are the long-term goal.

The tension between short and long-term goals must be acknowledged. Short-term efforts should focus on enhancing productivity, resource utilization, and material efficiency. They should also consider minimizing the impact of production on the environment. (UNEP. 2016b). This should be done in parallel with efforts toward a more sustainable economy. These include the goal of decoupling production from environmental impacts. The International Resource Panel (IRP), which is part of the United Nations Environment Programme (UNEP), has published numerous reports on the potential and implications of decoupling. These analyses suggest that it is necessary for the world to meet its sustainable development goals (UNEP 2011, 2014, 2016a).

Economists, policymakers, and industrial experts are starting to explore the Circular Economy's concept, which enables outputs from different stages of the lifecycle become inputs into others. It can help offset the energy-intensive activities and materials needed for new equipment.

Over time, the understanding of the circular economy has changed due to the emergence of new perspectives and theories. These include the concepts of energy flow and material flow loops. Theory influences related to performance economy have also been identified (Stahel, 2010), cradle-to-cradle (McDonough and Braungart, 2010), industrial ecology (Graedel and Allenby, 1995). The increasing number of key perspectives on the subject of circular economy has helped broaden the scope of our understanding Bocken et al. (2016). Through business model and design strategies, we can position the concept of circular economy to close resource loops Yuan, Bi, and Moriguichi (2006). The focus should be on the closed and circular flows of energy and materials, as well as how they are used across different phases of Chinese Circular Economy Promotion Law; and the Ellen MacArthur Foundation (World Economic Forum, and Ellen MacArthur Foundation, 2014). This segment explores the distinctions between technical and biological systems, their role within the framework of the industrial economy, and their influence on society.

Geissdoerfer et al. (2017). proposed a definition of the circular economy that is most relevant to this study. *"A regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling."*

The concept of the circular economy is a framework that aims to help prevent the loss of various functions and materials that are associated with traditional consumption (Ellen MacArthur Foundation, 2013). The benefits of the circular economy can be achieved through the engagement of various stakeholder groups in the development of new production and economic systems. However, to fully realize its potential, the system must first be designed to support and enable system circularity. Three key needs are identified to address these challenges.

1. Important factor that can be considered when implementing the circular economy is the capture and retention of materials at the gaps between the various lifecycle stages. This can help minimize the likelihood of loss, as well as improve the process' efficiency;

2. another important factors that can be considered when implementing the circular economy is ensuring that materials are recovered and retained at the highest possible value; and

3. To maximize the value of recovered materials, a remodeling of the linear system can be carried out through the development of new infrastructure, innovative processes, and product innovations. These will allow high-value inputs to be used in place of raw materials.

The various materials collected and re-used in the production of goods and services become crucial factors that policymakers and business leaders need to consider in order to make informed decisions. A growing focus on the innovation of existing production systems can help drive the circular economy. Various innovations in the production process, trade and policy frameworks, business models, and product design strategies can help pave the way for a more circular economy. This concept is especially relevant to the re-cycling of technical nutrients in a circular economy. The continuous improvement of existing

production systems and the creation of new ones are critical to the economic sustainability of future and existing circular economies.

To ensure that all corners of the globe achieve equitable and sustainable economic growth, it is essential that we identify and decouple production from the various detrimental effects.

2.5. The Idea of Circular Economy

The rise of the circular economy concept has been attributed to the increasing number of people interested in adopting a new approach to consumption and production. This new model is an alternative to the traditional linear system of consumption and production. It has been discussed since 1970. Some experts believe that the circular economy could help solve the environmental problems that we face by reducing the pollution and resource consumption of products. (Suave, 2016, p. 49). In contrast, other experts believe that the main focus of the economy is on the transformation of the utilization system's general functions. This means that the waste produced by factories and other manufacturing facilities can be utilized to make other goods (Suave, 2016, p. 49). An alternative definition is to focus on maximizing the possible extraction of a product's value by continuously utilizing it for a long time. This method can then lead to the recovery or reuse of the materials (Mitchel, 2015). The Ellen McArthur Foundation's more concrete definition of the concept shows that circular economy involves a continuous process of utilization:

“The circular economy refers to an industrial economy that is restorative by intention; aims to rely on renewable energy; minimizes, tracks, and eliminates the use of toxic chemicals; and eradicates waste through careful design.” (EMAF, 2012, p.22).

The concept of circular economy is also broad and includes the need to transform the way the industrial system is designed. It aims to create a system that is powered by regenerative and restorative processes, which are initiated during the product's design phase. Contrary to popular belief, the circular economy does not focus on the reduction of environmental pollution or waste. Instead, it aims to create a positive and neutral impact on the environment by designing products and industrial systems that are sustainable. (Murray, A., Skene, K.

and Haynes, K., 2017). The European Commission's Action Plan for the circular economy states that the concept has been extended beyond waste management and resources to encompass an overall strategy. Here is how the European Union's Commission describes the circular economy: “Circular Economy represents a development strategy that entails economic growth without increasing consumption of resources, deeply transform production chains and consumption habits and redesign industrial systems at the system level.” (European Commission; p.2, 2014).

In conclusion, the following specific definition of Circular Economy should serve as the foundation for a common understanding:

“Circular Economy is an industrial system that is restorative or regenerative by intention and design. It 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 for the elimination of waste through the superior design of materials, products, systems, and, within this, business models. The overall objective is to enable effective flows of materials, energy, labour and information so that natural and social capital can be rebuilt” (EMAF, 2012; EMAF, 2013; EMAF; 2015).

In order to provide a deeper understanding of the concept, a circular economy principles overview should be included in the next section.

2.6. The Intersection of Sustainability and Circular Economy

Although there are many different definitions of sustainability in the field of ecology and environmental systems, it generally refers to how natural systems can maintain a certain level of activity over time due to the limitations of human activity. (Bruntland 1987, Ehrenfeld 2005, Geissdoerfer et al. 2017). Current thinking about sustainability includes acknowledging the multiple interdependent systems that affect the environment, economy, and social well-being. (UN General Assembly, 2005). The concept of systemic and balanced integration of the various systems that affect the environment, economy, and social well-being is also widely acknowledged (Geissdoerfer et al., 2017).

Sustainability has been discussed and developed for a long time, unlike the circular economy discussion. Its objective is to benefit the various systems and stakeholders that affect society, the environment, and the economy (Elkington, 1997). The main difference between the two concepts is that sustainability emphasizes the planetary-scale issues and the need for collaboration among different groups to address them. On the other hand, the circular economy emphasizes the benefits of sustainable practices (Bruntland 1987, Geissdoerfer et al. 2017).

Nevertheless, it is crucial to acknowledge certain fundamental distinctions between the concepts of sustainability and circular economy in the context of this research. (Please refer to Table 2 for reference) The concepts of circular economy are mainly focused on the advantages that can be achieved through the industrial economy. This approach also recognizes the possibility of additional benefits that can be obtained from the social and environmental sectors. This approach is similar to the assumptions made by Cooper et al. (2017), which state that the consumer's behavior changes are not considered when it comes to the development of models and the discussion. The utility of the expected demand levels is maintained.

Although sustainability acknowledges the various roles that stakeholders have to play, the nature and influence of circular economy are focused on the roles of government and industry (Geissdoerfer et al., 2017).

As highlighted in Table 2, in accordance with the existing literature on the circular economy, and taking into account the accessibility of resources, the focus of this evaluation within the framework of the circular economy is limited to certain facets of the traditional sustainability perspective.

Table 1: compares the scope, stakeholder responsibilities, and emphasis on impact of sustainability and circular economy.

	Sustainability	Circular Economy
Scope Emphasis	• Broad interconnected *social, economic, and environmental* systems.	• *Industrial economic* systems.
Stakeholder Role & Responsibility Emphasis	• *All stakeholders* to social, economic, and/or environmental systems; • Differing, but equally important roles and responsibilities.	• *Government and industry*; • Other stakeholders as they may relate to the achievement of circular economy objectives.
Impact Emphasis	• *Broad environmental*: Views environmental systems as foundational and essential to sustainable social and economic systems. • E.g. energy consumption; environmental footprint; waste generation.	• *Economic and environmental*: The pursuit of negative environmental impact reduction, considered in context of the economic implications. • E.g. resource efficiency; material efficiency; resource productivity.

Modified from *Geissdoerfer et al. 2017*

CHAPTER 3
METHODOLOGY

3.0. METHODOLOGY

This chapter covers the various steps involved in the research for this master's thesis. It explores the philosophical foundation of social constructivism and the research design and implementation of the study. It also provides an overview of the data acquisition methods and the ethical issues that were tackled throughout the investigation.

3.1. Philosophical Position

The thesis's philosophical foundations are based on the philosophy of social constructivism. This focuses on the importance of context and culture when it comes to understanding society's activities and what it means to be a citizen. Social constructivism is predicated on particular assumptions about learning and reality (Saunders, et al.,, 2016).

Human activity is the foundation of knowledge, it is produced through the interactions between people. Social constructivists believe that learning is a process that involves people interacting with each other and their surroundings. Meaningful learning can occur when individuals participate in social activities. (Dubois & Gadde, 2002)

3.2. Research Design

This master´s thesis presents a qualitative research design. Through the design of the qualitative research process, it was able to reveal the various internal and external processes that influence the study's objectives. This method also allows the researcher to study the case phenomena that occur in the context of the study (Baxter and Jack , 2008).

This thesis is written in a descriptive and explorative manner. Through its exploratory approach, the study revealed how the principles of circular economy can help improve sustainable management of supply chain management. The descriptive part of the research also allowed the reader to observe the circular economy practices in the fish farm setting. (Braun & Clarke, 2006; Tashakkori & Teddlie, 1998; Yin, 2003).

The objective of the thesis is to gain a deeper understanding of the subject by learning what the experts think about it (Creswell and Poth, 2016).

Deductive and inductive methods are two different approaches that can be used to connect theory to reality. The deductive and inductive approaches can be characterised as follows:

"deductive approach is a theory testing process which starts with an established theory or generalization and seeks to test if the theory matches to specific instances while inductive reasoning is a theory building process which starts with observations of instance and aims at establishing generalization" Hyde (2000, p.83).

The thesis looked into a combination of the inductive and deductive methods. The analysis was conducted using the latter's testing theory, while the inductive method was utilized when the principles of circular economy affected the current practice.

3.3. Case Study Approach

This master's thesis applied a single case-study approach based on the fish farm in Møre og Romsadal Norway. Norway is known to be a leader in the fish farming industry, which is regarded as one of the country's most vital industries. It is also the largest producer of salmon in the world, which contributes to the nation's economic, environmental, and health impacts. The study sought to explore how the circular economy could enhance the sustainability of this sector. The Case study techniques helped me to understand the phenomenon in real-world settings, and they also allowed me to explore the internal processes that influenced the development of this thesis.

The citation provided by (Yin Robert K., 2003) clearly defines the concept of the approach.

"A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident "

3.4. Case Description

The case company is one of the few family-owned aquaculture businesses in Norway, the case company has been active in the sector since the 1970s. It has created a unique ecosystem within the sea gap on Nordmøre. The farm employs over 60 workers and produces high-quality products in Aure and Smøla. They primarily raise roe, smolt and finaly salmon are able to harvest and sell them to the international market.

The company's approach to sustainable salmon production involves minimizing its environmental impact while still protecting the fish's welfare. This caught my attention and piqued my interest, which motivated me to look into how this practice could be applied within a hatchery setting.

3.4.1. Data Collection

The study encompasses two distinct areas of information collection, namely primary and secondary data. Primary data can be collected through the means of interviews and observations, while secondary data refers to pre-existing data within the research domain (Saunders, Lewis, and Thornhill. , 2016). This master thesis was based on both primary data and secondary data.

3.4.2. Primary Data

For this master thesis, the primary data was gathered through face-to-face interviews, as well as other sources such as personal observations and internet research.

3.4.3. Interview

In total, I conducted five interviews from March to April of 2023 (See Table 3.5.2.1). Three of these were on Zoom with the case fish farm and 2 interview with Salmon Center in Molde.

A total of 4 semi-structured interviews were held with representatives from various departments within the focus company, as well as experts in the field of fish farming. Three interviews were conducted using the Teams platform, while one interview took place in the offices of the interview participants at the Molde Salmon Centre. These interviewees were chosen based on their extensive experience, practical knowledge, and involvement in the Norwegian fish farming industry.

The interviews were carried out in the English language. The interviews were documented after obtaining written agreement from the participants and transcribed manually to maintain the integrity and reliability of the collected data. The interviews were done between the months of March and April 2023 with the case company and in August and September 2023 with experts (See See Table 3.5.2.1)

The implementation of semi-structured in-depth interviews facilitated a greater level of information richness and personal engagement among the interview participants in their responses to the posed questions. Semi-structured interviews proved to be advantageous as they allowed for the adaptation of questions in response to the natural progression of the conversation (Saunders, Lewis and Thornhill, 2016). Additionally, these interviews provided the opportunity to prompt participants to further elaborate or expand upon their responses.

Due to ethical concerns, the actual identities of the participants were not disclosed. Prior to the commencement of the formal interview, a set of interview instructions containing a series of questions was distributed to all participants involved in the study (see to Appendix 1). In order to allocate sufficient time for the examination candidates to thoroughly review and understand the questions beforehand. The subsequent inquiries were conducted using electronic mail and telephone conversations, in accordance with the suggestion put forth by (Walliman, 2011)

This table provides a comprehensive summary of the conducted interviews, including pertinent details such as the titles of the respondents, the dates on which the interviews took place, their respective durations, the locations in which they were conducted, and the specific topics that were discussed during each interview.

Table 3.5.2.1: *Overview of the interviews, respondent titles, date, duration, location and topic of interview discussed.*

Respondents(s)	Company	Positions	Date	Duration	Location	Topic of Interview
1.	NEKTON (Case company Fish Farm)	CEO	19.03.2023	1 hour	Microsoft Teams	❖ General questions ❖ Operation and Logistics ❖ Chalanges in the production ❖ Sustainability and Circular Economy ❖ Complycity of the Management of live fish transportation
2.	NEKTON (Case company Fish Farm)	Biologist and Quality Manager	19.03.2023	50 minute	Microsoft Teams	❖ General questions ❖ Operation and Logistics ❖ Chalanges in the production ❖ Sustainability and Circular Economy ❖ Complycity of the Management of live fish transportation
3.	Salmon Center Molde	Salmon Center Molde	18.04.2023	1hr 45 minute	Face to face, Molde	❖ General questions ❖ Sustainability and Circular Economy ❖ Fish farming in Norway
4.	Salmon Center Molde	Scientist	02.05.2023		Face to face, Molde	❖ General questions ❖ Sustainability and Circular Economy ❖ Fish Farming in Norway

3.4.4. Personal Observations

According to (Yin, Case Study Research: Design and Methods. Case Study Research and Applications: Design and Methods 5th ed. Los Angeles, 2014) the use of personal observations is a valuable approach for acquiring firsthand knowledge and obtaining comprehensive understanding.

In April 2023, I acquired significant insights into the technological advancements and innovative practices employed within the fish farming sector during my visit to Salmar's visiting centre in Molde. During the tour, participants were provided with the opportunity to engage in a simulation of a control centre that digitally oversees numerous places. Additionally, they were able to acquire knowledge pertaining to the life cycle of salmon. During this particular tour, I acquired knowledge regarding the land-based farming operations of Salmon Evolution, the focal case company in the thesis.

A substantial quantity of empirical data was gathered during a visit to case fish farm situated on the Norwegian island of Smøla on March 19th, 2023. I personally observed the production process of salmon, from the initial stage of roe to the development of mature salmon, at the smolt plant. During my observation, I encountered several noteworthy aspects pertaining to fish vaccination, including the implementation of a recirculating water system, the transfer of salmon from freshwater to seawater, as well as the transportation of live fish for processing purposes. While the fish were being fed, I stood on the sea cage. Through personal observations, I have gained a deeper understanding of the organisation and growth of fishing and production processes.

3.4.5. Triangulation

This research applied various data sources to ensure data triangulation. Triangulation of data refers to the practise of gathering data from many sources, such as interviews, observations, and document analysis, in order to enhance the reliability and validity of the research findings (Creswell and Creswell, 2017). The utilisation of data triangulation serves to

enhance the credibility and robustness of our research findings, as emphasised by (Yin, Robert K, 2018).

(Fink, A, 2003) has claimed that:

"Triangulation focuses on the collection of data from different sources like field notes, interviews et cetera or from different surveyors in different places, thus the credibility of the data collected is highly enhanced with the use of multiple sources as the information produces similar results."

The utilisation of many data sources facilitated our investigation of the phenomena by providing a more comprehensive depiction, as the diverse views offered by each source contributed to a deeper understanding (Collis and Hussey, 2013) argue that the acquisition of distinct impressions provides a more comprehensive understanding of the phenomenon at hand.

3.4.6. Secondary Data

The primary sources of secondary data utilised in this master's thesis predominantly consist of scholarly publications and journals obtained from the academic databases of the educational institution, ScienceDirect, and Google Scholar. These sources were accessed by conducting targeted searches on the subject matter of Circular Economy and Sustainable Supply Chain Management. The empirical data's secondary sources encompassed archive papers, press releases, reports from corporate companies, and official websites. The utilisation of secondary data has contributed to the enhancement of comprehension in this particular case study.

According to (Saunders et al., 2012). In almost any research study, the utilization of secondary information is essential. This provides the necessary data to carry out the next step of the research.

3.4.7. Data Analysis

(Yin, 2016), posits that the examination of qualitative data progresses via a series of five distinct phases.

1) The process of compiling involves transforming source code into executable machine code.
2) Disassembling refers to the reverse engineering process of converting machine code back into assembly language or high-level programming language.
3) The process of assembling and arranging.
4) The process of analysing and understanding the meaning or significance of information or data.
5) Formulating a final assessment or opinion based on the analysis and interpretation of the available information or data.

The process of data analysis is expected to exhibit a non-linear pattern, characterised by iterative movement between several stages (Yin, 2016), assert that while there exist established analytical methodologies, there also exists a diverse array of approaches for analysing qualitative data (Lester et al. , 2020).

The collected data consisted of fragmented pieces of the conversations of the respondents. Data analysis was carried out to compare the knowledge about sustainable SCM and circular economy principles with my interviews and observations. The findings of the study revealed that Norway has unique management practices for fish farming (Miles and Huberman, 1994).

The transcribed interviews were compared and read to make sure that the participants' words were captured properly. An analysis of the opinions of an expert on the circular economy from Norway's research institute and a fishing farm were then used to explore the key issues.

3.4.8. Research Quality

The primary objective of this master's thesis is to conduct rigorous and high-quality research. In the following subsection, a detailed account is provided of the methodology employed to address concerns pertaining to the validity, reliability, and generalizability of the present master thesis.

3.4.9. Reliability

The concept of reliability pertains to the extent to which an experiment may be repeated, allowing for the possibility of replication and the expectation that the obtained results would remain consistent. Reliability in the context of a case study is contingent upon two primary factors: the establishment of a comprehensive case study protocol and the creation of a robust case study database. The case study protocol refers to the interview guide utilised in the study, while the case study database encompasses duplicates of the finalised interview guides, transcriptions, recordings, and supplementary data gathered (Ellram, 1996). The interview guide was distributed to the interviewees several days prior to the scheduled interview. The interviews were transcribed, and subsequently, the transcriptions were returned to the interviewees for the purpose of verifying and rectifying any inaccuracies in the information. This mode of communication facilitated the prevention of any misunderstandings.

During the course of the interviews, as a researcher, I made a conscious effort to avoid expressing personal viewpoints that would potentially influence the participants in an unintended manner. I paid specific attention to the manner in which I interpreted the information derived from the primary data. The necessity of interpreting data lies in its role in guiding the outcomes of a study, as researchers rely on their interpretation to establish guidelines.

In order to enhance the credibility of the investigation, secondary data was used as a supplementary source of information. The primary data was supplemented by secondary data obtained from articles, the official website of the focus company, and press releases.

This information is publicly accessible and can be used by any individual interested in conducting research.

3.4.10. Validity

According to (Easterby-Smith, Thorpe and Jackson, 2015) validity is defined as:

> *"the extent to which measures and research findings provide an accurate representation of the things they are supposed to be describing."*

Validity was ensured by the meticulous construction of a robust research design and the implementation of strong data collection methodologies. The data collection was triangulated and a combination of multiple data sources was utilised to obtain diverse viewpoints for the inquiry. (Creswell and Creswell, 2017) argue that this contributes to the overall validity of the study.

3.4.11. Generalization

The case study design has frequently faced criticism for its generalisation, with numerous researchers perceiving it as lacking scientific integrity. Another prevalent misconception regarding case-study research is the notion that it is not possible to draw generalisations from a single case, hence rendering the single-case study irrelevant in terms of scientific progress.

(Flyvbjerg, B, 2006) addresses this misconception by highlighting that:

"One can often generalize based on a single case, and the case study may be central to scientific development via generalization as a supplement or alternative to other methods. But formal generalization is overvalued as a source of scientific development, whereas "the force of example" is underestimated" (p. 228).

(Yin, R. K. , 2003) defines two distinct categories for extending findings from a case study to theory: analytic generalisation and statistical generalisation. Analytical generalisation is a method that involves the utilisation of case studies, similar to experiments, in which pre-existing theories are employed as a framework for evaluating the empirical findings of the case study. Analytical generalisation refers to the process in which the researcher attempts to extend a specific set of findings into a more comprehensive theoretical framework. The concept of statistical generalisation, in contrast, is rooted in empirical research that draws conclusions about a broader population based on data acquired from a specific case study.

The generalisation of the data in this master's thesis was achieved through the utilisation of analytic generalisation, which is recognised as a prevalent approach in case study research. The present study involved a comparative analysis of prior research with the findings obtained from the conducted case study.

3.4.12. Ethical Issues

According to Saunders, Lewis, and Thornhill (2016, p. 264), ethics play a crucial role in the realm of research.

"standards of behavior that guide your conduct in relation to the rights of those who become subject of your work, or affected by it."

Ethical considerations may arise at various stages of the research process. In this study, I openly communicated with the company regarding the investigation and its subject matter. This approach aligns with what Saunders, Lewis, and Thornhill (2016, p. 222) refer to as traditional access, which involved conducting face-to-face interviews and observations.

The present study gathered data from individuals employed in the aquaculture sector for the purpose of a master's thesis. The primary objectives include comprehending real-world occurrences, strengthening the credibility of study findings, and maintaining scientific integrity. The assignment included the inclusion of crucial ethical issues, which included the

safeguarding of the rights of the participants (Saunders, Lewis, and Thornhill, 2016, p. 264). Master hovik

Prior to initiating the interviewing process with the company and other relevant participants, I submitted the interview guide to the Norwegian Department for Data Collection (NSD) for approval. The present application facilitated the establishment of a consent agreement containing five different types of information relating to the project (see Appendix 2), its objectives, the subject matter, and the rights of the responders. Upon receiving approval from the National Survey Department (NSD) for the interview guide (see Appendix 2) , I immediately initiated communication with the company and other relevant participants in order to find out whether they had an interest in participating in the interviews. Subsequently, the interview guide and the consent agreement were sent out to the relevant respondent, with the aim of providing them with an understanding of the nature of the assignment and the expectations associated with their potential participation. The consent agreement required signature and, as previously said, it provided information regarding the rights of the respondent, such as the voluntary nature of participation and the ability to withdraw from the research at any point. This implied that participants had the right to request the researcher to delete all data gathered at any given point in time. The procedure mentioned above was conducted in accordance with the specified regulations.

In order to safeguard the confidentiality of the participants, I implemented a number of protocols. The data gathering guidelines of Molde University required the use of an authorised audio recording device. The interview recordings were not retained, and sole access for transcription purposes was limited to the author. The data obtained from the interviews was treated as confidential and was only shared with the thesis supervisor, ensuring its confidentiality. Although the actual identities of the participants were not disclosed in the thesis, prior authorization was given to include the real names of their respective organisations and their corresponding job designations.

In relation to the use of secondary data, I have carefully adhered to the Chicago reference system in order to appropriately attribute all citations and theoretical elements. This practice has been used to properly acknowledge the contributions of other authors and previous research efforts that have been included in my thesis. The difference between my original work and concepts and those that are not mine has been clarified.

In addition, I have maintained an exploratory approach throughout the analysis and discussion, aiming to maintain objectivity in relation to the findings and their consequences.

CHAPTER 4

FISH FARMING IN NORWAY

4.0. FISH FARMING IN NORWAY

The Norwegian fish farming industry exhibits a significant degree of specialization. Over the past few decades, the industry has seen a phase of consolidation. The Norwegian market is dominated by a few groups of enterprises that hold a significant share of the overall harvest volume, both within Norway and on a global scale. In the year 2021, it was observed that the aggregate production volume in Norway was predominantly contributed by the top 10 enterprises, amounting to around 71% of the entire output. The five highest-ranking companies constituted around 56% of the total volume in Norway. The Mowi Group is the dominant player in terms of total output, accounting for around 20% of the whole volume in Norway. By incorporating international production, Mowi has established itself as the leading global producer of salmon (Mowi Global, 2022).

4.1. Developments in Norwegian Aquaculture Since the 1970s

The Norwegian fishing industry and its economic significance have a long-standing history. Since the 12th century, the northern region of Norway has been actively involved in the exportation of preserved cod and herring to England (Sahrhage and Lundbeck, 1992). During the period spanning the 14th to the 16th century, the cities of Bergen and Trondheim emerged as prominent trading hubs, facilitating the exchange of salted and dried fish. These cities played a crucial role in the economic landscape of northern Norway, as well as other European nations. During the 18th century, the regions of Finnmark and Lofoten gained significant importance in the fishing industry due to their cod fishery (Haaland and Svihus, 2011). The Atlantic Salmon agriculture sector, with a history of approximately 40-50 years, can be regarded as rather nascent. Norway has been recognised as a pioneering nation in the field of aquaculture since the inception of its sector in the 1960s (Nash, 2010).

The time span from 1970 to 1989 represents the initial phase of growth and advancement within the sector. During this particular era, the industry commenced large-scale production, encompassing a significantly larger geographical region compared to previous periods. The cost of production for the sea pen decreased, rendering it more affordable, while its maintenance requirements were simplified. During this particular time frame, there were

limited occurrences of noteworthy events taking place. One significant development was the formation of the Norwegian Fish Farmers Association (NFFA), which aimed to foster collaboration among fish farmers and serve as an intermediary between the industry and regulatory bodies. Another notable event occurred in 1972 when the government established the Lysø Committee, as mentioned by Michaelsen (2019). In the span of a single year, the committee recognized the necessity of implementing a licensing system, leading to the creation of the preliminary act titled "Construction, resources, establishment, and growth of facilities for hatching eggs and fish farming" (Hovland et al., 2014). Another significant occurrence within this time frame was the formation of the Fish Farmers Sales Union (FFSU) in the year 1978. According to Michaelsen (2019), the Aquaculture act of 1981 marked the establishment of the initial legislation pertaining to permanent aquaculture practices. Nevertheless, this legislation underwent numerous revisions until 1985 as a result of its evolving nature and the significant opposition it faced (Michaelsen, 2019).

The time span from 1990 to 2010 can be characterized as an era marked by the processes of industrialization and the pursuit of environmental sustainability (Hovland et al., 2014). During this period, a modification was made to the Act of 1985. The prohibition on individuals or companies holding a majority stake in multiple licenses ended in 1991. A further significant occurrence entailed the founding of the state-owned Norwegian Seafood Council. Norway's accession to the European Economic Area (EEA) as well as European Free Trade Association (EFTA) granted it the advantageous prospect of unrestricted entry into the European Market. The current time frame holds significant importance for the Norwegian Aquaculture industry, as it marks the period during which the government made a strategic decision to redirect its approach to leadership towards a more technological, sustainable, and scientifically informed structure (Hovland et al., 2014).

The early days of the industry may be traced back to the enactment of the Food Act in 2003, followed by the establishment of the Food Security Authorities in 2004 (Hovland et al., 2014). This year has been significant due to the introduction of many standards aimed at enhancing the operational efficiency of the aquaculture business. An additional significant year within this time frame is 2005, when the 1996 feeding allotment was substituted by two variations of MAB (Maximum Allowable Biomass) as the novel management instrument (Hovland et al., 2014). The Aquaculture Act was implemented in 2006, replacing the previous legislation known as the 1985 farming act. Additionally, much attention was

dedicated to the maintenance of fish health and the prevention of diseases. During this particular time frame, there was a noticeable rise in the scarcity of appropriate areas for the practice of fish farming. The potential for disagreement between fish growers and recreational fishermen escalated due to their shared utilization of the same geographical area and their competition for the identical resources (Hovland et al., 2014).

In 2010, the government recognized the need to establish an improved management system that would enhance predictability and effectively tackle the limited availability of suitable places for large-scale fish farming. The Gullestad committee was established by the government during that period in order to generate recommendations on the effective utilization of the coastal zone for the aquaculture sector, as well as propose a novel management structure to enhance the sustainability of the industry. In 2011, following a year of diligent effort, the committee delivered its report, which incorporated three primary recommendations along with several supplementary proposals. According to (Hovland et al., 2014), three noteworthy recommendations were put forth. Firstly, it was proposed to divide the coastal zone into different production areas that are self-contained. Secondly, the suggestion was made to develop indicators that can effectively address the challenges faced by the industry. Lastly, it was advised to stay away from granting new licences to fish farms until the establishment of the new system for management.

From the period of the report's publication up until October 2017, a series of significant events occurred. In 2012, The Ministry of Trade, Industry and Fisheries (MTIF) implemented technical regulations by establishing indicators and standards that are grounded in environmental factors. In 2013, MTIF distributed a total of 45 licenses among three groups during a round known as the "Green concession round." In 2015, the government made an announcement regarding an additional concession round, that served as an indication of the implementation of a new management structure. According to the Department of Finance (DoF, 2017). The Norwegian Ministry presented a document titled *"Predictable and environmentally sustainable growth in Norwegian salmon and trout farming"* as the 16th White Paper over the period of 2014-2015 (Michaelsen, 2019). Following the submission of the report, the management devoted their utmost dedication to the development and implementation of the novel management system. The management system, known as "The Traffic Light System," was officially approved and implemented on October 30, 2017 (Michaelsen, 2019).

4.2. Regulation of the Fish Farming Industry in Norway

In order to participate in salmon farming business in Norway, it is a legal obligation for the company to possess a valid license. The licenses in issue are subject to limitations imposed by the government in order to regulate and restrict expansion. Furthermore, these licenses are allocated through auction processes. When a company is granted a license, it acquires a highly valuable asset. One advantage of this arrangement is the potential for a proprietary operation on Norwegian land, provided that the conditions established by the governing bodies are adhered to. The key concepts revolve around the well-being of farmers' operations and their significant contributions to local and national value development. In essence, a "social contract" exists between the fish producers and the Government (Fiskedirektoratet, 2022). According to a report by Kontali Analyse (2022), the allocation of licences for Atlantic salmon and trout in seawater was restricted to a total of 1260 in the year 2021. Typically, a single license allows for a maximum acceptable biomass (MAB) of 780 tones. An exemption to the aforementioned regulation can be observed in the counties of Troms and Finnmark, where a single license allows for a maximum allowable biomass (MAB) of 945 tones. Furthermore, it is important to note that each production site is subject to specific limitations on its maximum allowable biomass (MAB). In the past, the distribution of licenses has occurred irregularly and has been determined by various criteria (NOU 2019:18, 2019, p. 44). A corporation has the ability to possess numerous locations, with each location potentially housing various licenses. Nevertheless, it is important to note that every site possesses a finite capacity restriction. The imposed capacity limit has resulted in a constraint on the production of farmed salmon, thus leading to a significant escalation in salmon prices.

4.3. Recirculating Aquaculture Systems (RAS) As Technology

The deployment of fish farming technology is vital in order to guarantee the production of high-quality salmon and mitigate potential environmental and social repercussions. This technology serves to address concerns such as salmon escape, waste management, water recycled and reuse and the implementation of necessary measures to safeguard against adverse effects. Closed systems in aquaculture effectively separate the aquaculture systems from natural aquatic systems, hence reducing the potential for disease transmission or genetic influences on the external ecosystems.

The RAS (Recirculating Aquaculture method) is an example of a land-based closed containment aquaculture method. The management of water inflow and outflow within the system can be fully controlled. In Norway, the effective use of recirculating aquaculture systems (RAS) is primarily observed in the cultivation of smolts and post-smolts. However, ongoing research and experimentation are being conducted to explore the potential of RAS for efficient grow-out production. The utilization of land-based production methods for fish cultivation addresses the significant challenges associated with fish escapes and salmon lice in fjord aquaculture, as highlighted by Lekang et al. (2016). In a Recirculating Aquaculture System (RAS), a significant proportion, often ranging from 95% to 99%, of the water is recycled for reuse (Timmons and Vinci, 2022). Additionally, the system also facilitates the recovery and reuse of heat (Workshop, 2014). Production in Recirculating Aquaculture Systems (RAS) has the ability to provide salmon with an optimal habitat for growth and wellbeing by offering protection against diseases and ensuring the provision of ideal living circumstances. According to Toze (2006), effluent water has the potential to be disposed of in a sustainable manner or repurposed for several other applications, such as agricultural usage. The ability to engage in year-round farming provides a reliable food supply to markets and has the potential to decrease the duration of travel between producers and consumers, hence decreasing transportation expenses and environmental pollution. According to the Commission (2020), RAS has the capability to cultivate breeds that are not indigenous to the prevailing climatic conditions. According to Timmons and Vinci (2022), the intense farming technique shows greater efficiency per unit area and requires fewer staff compared to other aquaculture systems. This is the reason why Recirculating Aquaculture Systems (RAS) are regarded as a viable and sustainable choice for salmon cultivation.

The proportion of land-based aquaculture production, namely from the egg stage to post-smolt, utilising either recirculating aquaculture system (RAS) technology or flow-through systems, varies among producers. However, there is an observable tendency towards transitioning to RAS, as indicated by Meriac (2019). Historically, flow-through systems have been widely employed as the predominant technology for smolt production in Norway. Nevertheless, recent developments in the Norwegian agricultural sector indicate a growing adoption of Recirculating Aquaculture Systems (RAS) for the cultivation both of the smolts and post-smolts. The flow-through system is considered to be more manageable compared to the Recirculating Aquaculture System (RAS) due to its lack of water recirculation. One

of the contributing factors to the decline in the utilization of flow-through systems is the requirement for consistent and substantial water intake and discharge. The scarcity of water has led to the increased relevance of Recirculating Aquaculture Systems (RAS) as a technology that enables greater productivity with a limited water supply. In a flow-through system, the level of environmental control and biosecurity measures is comparatively lower, hence increasing the likelihood of welfare-related issues. Waste management poses a significant difficulty in flow-through systems due to the less comprehensive filtration of effluent compared to recirculating aquaculture systems (RAS) (Timmons and Vinci, 2022).

A comprehensive management strategy for the Recirculating Aquaculture System (RAS) is important in order to maintain water quality within the prescribed parameters for optimal fish production. The specific requirements for managing RAS may differ based on the species of fish being cultivated and the architecture of the system. All Recirculating Aquaculture System (RAS) facilities consist of several essential components, including a fish tank, biofilter, mechanical filter, degasser, oxygenator, and heat exchange system.

4.4. Production Process

4.5. The Aquaculture Value Chain

The production cycle of salmon and rainbow trout spans around three years and includes a diverse array of sequential operations. To put it briefly, the process begins with roe, or eggs, and ends with fillets on dinner tables worldwide. Further I discusses the cycle into six distinct phases and the subsequent section of this subchapter provides a detailed explanation of each step in a chronological manner.

The process of initiating each generation of fish involves a careful selection of roe based on the farmer's specific preferences. In the past, preferences were mostly determined by the specific river from which the fish originated, with the belief that fish from more turbulent rivers were generally stronger and healthier. In modern times, the utilization of genomic selection and systematic breeding has resulted in the development of more precise preferences in several areas. These preferences include factors such as meat quality and color, growth rate, enhanced immune system, sterility, and others (Aquagen As, 2019).

Once the farmer has selected the desired gene characteristics, the roe producer combines the suitable eggs with milt in order to commence the process of fertilisation. The fertilised eggs undergo a period of close monitoring lasting around seven to nine weeks within small incubation tanks containing freshwater. Once the eggs reach a suitable level of strength, usually during the eye-roe stage, they can be transferred to smolt production plants as part of the second phase of the production cycle.

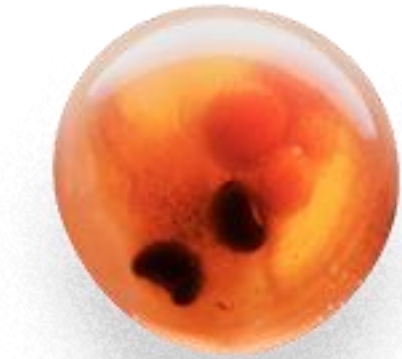


Figure: 4.5.2. picture of single roe the eye-roe stage (Salmon egg) 0 months older
Sourse: laks.no

At the smolt facility, experts reintroduce the fish eggs to compact incubation tanks. Upon accumulating around 500-degree days, the roe undergoes the process of hatching, resulting in the emergence of larvae. Following this, the larvae are transferred by experts to large freshwater tanks, where they undergo a six-month period of development. During this period, the larvae experience a series of developmental stages, transitioning from Fry to Parr, and ultimately experiencing a transformation known as "smoltification" to acquire the capability to survive in environment with high saline levels. The developmental progression from larvae to smolt involves a substantial increase in body weight, typically reaching approximately one hundred times the starting weight. typically, the fish weighs between 80 to 150 grams upon transfer to a life at sea.

These vessels, which are known as wellboats, are mainly used to transport fish from a small smolt facility situated on the sea to nearby production sites. These localities are usually composed of several pens, each with a circumference of around 120 to 200 meters. These pens can hold up to two hundred thousand fish, and each circle can measure up to 200 meters wide, making it ideal for holding large groups of fish (Forskrift Om Drift Av Akvakulturanlegg, 2004). The wellboats are equipped with a feeding bridge and silos, which allow technicians to monitor the fish's appetite and set the appropriate feeding schedule. The feeding schedule is based on various factors such as the growth rate, average size, and the feed conversation ratio.

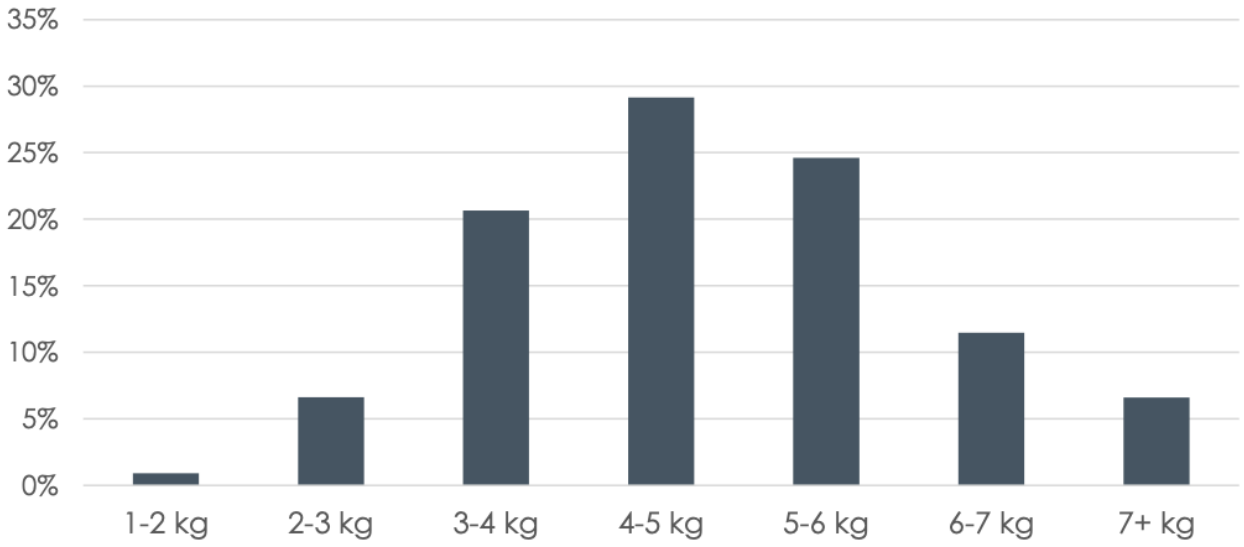
The present practice of farming utilizes open-net technologies, wherein water can freely flow through a pen. This type of technology is advantageous for companies as it does not require the use of energy to produce fresh and oxygen-rich water. Furthermore, open-net technology eliminates the need for additional systems to deal with waste, such as excess feed, fecal matter, and manure. On the other hand, it is vulnerable to various externalities, such as natural surroundings or within a certain locality, where diseases and parasites commonly occur. Parasites have become a major cost-driver for farming companies in recent years. Open-net technology has a negative effect on the ecosystem, as it allows waste to be released and processed carelessly. It also provides an ideal environment for the growth of parasites, which can negatively affect wild fish. Figure 2 and 2.1 illustrates the complex interplay between the ecosystem and a fish pen. The force of impact is indicated by the direction of the arrows, and the sum of all factors defines the animal welfare inside the net. Agnalt et al. ((2018) (in Norwegian and in English) provide a full study of the impacts.

Farmers keep the fish under regular supervision because to the constant threat of negative externalities, and authorities need weekly reporting on, for example, lice levels. When lice levels exceed a certain threshold, mitigation measures are required. Farmers have at least six alternatives for dealing with the lice problem. They can begin by using medication medicines such as Alphamax, Betamax, or Salmosan. However, due to their rapid reproduction and adaptation, lice have developed medical resistance to several of them (Helgesen el al., 2019). Second, they can use non-medical treatments such as Thermolicer, Optilicer, Skamik, or wellboats. These methods involve pushing the fish through complicated machinery and either brushing the lice off (Skamik), using heated water in which most lice can't survive

(Thermolicer and Optilicer), or exposing the lice to freshwater (wellboats). Although the procedures are somewhat efficient, they cause considerable stress and suffering to the fish, as well as increased mortality (Hjeltnes el al., 2019). Furthermore, they necessitate extensive manual labour and big capital inputs. A third option is to use medical feed, such as slice. Slice involves adding a chemical (emamectin benzoate) to the feed pellets, which the fish absorbs and spreads to its tissue. When a louse clings to the fish and begins eating from the skin, the chemical paralyses the louse by blocking nerve signals, and the louse dies (MSD Animal Health AS, 2012). A fourth technique is to introduce cleaner fish, such as lumpfish and wrasse, into the pen to consume the lice. This method is gaining popularity among farmers, and the industry releases over fifty million cleaners into pens each year (DoF, 2019). Chemicals such as hydrogen peroxide are used as a fifth technique. Although this practise has a long history, farmers rarely use it today due to the possible harm it could cause to wildlife (Agnal et al., 2018). The sixth and last technique is an early harvest, which is often regarded as a last resort by farmers due to the significant alternative expenses.

The fish is ready for harvest after 14 to 22 months at the location with periodic treatments and daily maintenance, with an ideal weight of close to five kilogrammes. The graph (figure 3) shows the distribution of Norwegian harvest in 2021. The most frequent size of harvest is around 4-5 kg. This is due to the need to cater for the market's requirements and the farmers' desire to maintain a balance between biological and market risks. The smaller harvest size can be attributed to various factors such as disease and early harvest. On the other hand, larger fish can be produced in response to the market's requirements and economies of scale.

Figure 4.5.2.. Size distribution in 2021



Sources: Salmon Farming Industry Handbook 2022

The livestock is transported by a wellboat to the nearby processing plant. The fish are then deposited into either a holding pen or factory. The latter is a small pen that's connected to the factory. The latter provides the fish with a natural environment that de-stresss them. Doing so helps reduce the levels of cortisol, lactic acid, and other harmful chemicals in the body. (Skjervold et al., 2001).

The first step in the processing process involves transferring the fish into large cold water tanks. The tanks will then allow the fish to adjust to the cold water and lower its stress levels in order to prevent it from developing rigor mortis. After cooling down, the fish is placed in the slaughtering machines. It gets a sharp blow to the head and cuts its main artery, which connects the gills to the abdomen. It then bleeds out before it is completely dried. The initial phase of the processing is then called gutting, which involves the taking of entrails, as well as the flushing of the meat. Every fish is graded according to its various characteristics, such as its appearance, health, and color. It can be classified as either the best, the ordinary, or the worst. The price of the product is determined by the grade given. The entire process, which includes the packaging of the fish, is referred to as primary processing. The secondary processing stage involves everything that follows.

Secondary processing includes any value-added operation and can take several forms. Secondary processing often entails removing the head and tail, filleting, and trimming

(Johansson, 2017). The fish is then prepared in many ways, such as fillets with or without skin, loins, smoked, burgers, and so on.

Sales are the final stage of the production process. Norwegian farmers export over 95% of their domestic produce, primarily as gutted and entire fish (Mowi, 2019). As a result, Norwegian-farmed salmon and rainbow trout are now available in most parts of the world.

This brief overview of the value chain of rainbow trout and Norwegian salmon farming provides a deeper understanding of the interaction between the ecosystem and the farm. The most crucial takeaway is the knowledge of externalities during the farming phase and the long production cycle, which is crucial since decisions regarding future volumes are made several years in advance.

CHAPTER 5
CASE PRESENTATION

5.0. CASE PRESENTATION

This chapter presents the empirical findings from the case fish farm located in the northern part of Møre og Romsdal, Norway. The chapter describes fish farming operations within the case fish farm the storytelling in this chapter is presented according to the research questions presented in Chapter 1, including supply chain operations, drivers and enablers for sustainable practices, challenges, and the implications of sustainable fish farming practices.

5.1. Empirical Case Presentation

The case fish farm is located on the island of Smøla in Møre or Romsdal County. Although the case fish farm appears to be small, it is actually rather large. It all started on Smøla. Since the 1970s, the case fish firm has been run by a family. The fish farm is one of the few remaining family businesses in the sector, with roots dating back to the pioneering days of the 1970s. They have been involved in ongoing development since then. 60 happy employees work each day with everything from roe to salmon, all of which is of exceptional quality.

Case farm has developed a one-of-a-kind aquaculture environment in the sea gap on Nordmre. Every day, approximately sixty proud staff work with everything from roe to fish of the highest quality. They breed roe, smolt, and eventually slaughter-ready salmon in Aure and Smøla, which are marketed on the global market.

The case fish farm is a proud organizer of meeting sites such as Smolttinget, because they believe it is crucial that the fishing sector gets together. The Smolttinget is held annually at the Smøla Sea Fishing Center and includes a professional program with lecturers, followed by a social gathering and the sea's party table in the evening. They feel that interaction between business, politicians, and citizens is critical for developing the next generation of farmers. They are eager to offer their knowledge. It is one of their guiding principles.

Teaching with the aim of recruiting local labour. At Smøla,

"we are concerned with the next generation. We have our own viewing center and we welcome anyone who wants to learn with open arms, we also

collaborate with Kristiansund VGS to contribute to Nordmøre getting the best aquaculture education. As an industry, we need local, competent and practical labor in the future"

says the CEO.

The case fish farm also have the best conditions to provide good practical teaching in aquaculture education in the environment where the values are created and they have the latest and greatest in technology and have several ongoing research projects of their own.

"We are local and we never give up on development of fish farming".

For better environment and sustainable development, the case farm wants to be an active contributor to the sustainable development of the aquaculture and farming industry. Along the coast, they have good conditions for producing healthy food for a growing global population. The farm has the GlobalG.A.P. certification. GlobalG.A.P. is an international standard for food safety and is a voluntary certification for everyone involved in food production in the world. The main requirements to be certified through GlobalG.A.P. are to minimize the environmental impact on farming operations, reduce the use of chemicals and that the company has a responsible approach to employee health in addition to good animal care. GlobalG.A.P. has developed standards for both agriculture and aquaculture. The standard exists for consumers to show that the food, - in this case the farmed salmon, has been produced in accordance with the strict requirements required to be certified as a GlobalG.A.P. - producer.

The GlobalG.A.P. standard assures consumers that the salmon has been produced in a farm under the following requirements:

- Low environmental impact from farming operations
- Reduced use of chemicals
- A responsible approach to employee health and safety

The case fish farm currently has two licenses for the production of edible fish. A viewing license and a Green C licence. The food fish for case farm is produced in collaboration with one of the biggest salmon producer in Norway (SalMar) through co-location. The farm is certified to produce quality salmon that is placed on niche markets around Europe.

"We are immensely proud to produce world-class salmon that is preferred by quality-conscious customers".

5.2. Operations And the Production Cycle of The Case Fish Farm

The main business of the case farm is the Smolt production at land in freshwater tank. Usually, the case farm buys the roe locally (broodstock genetics), then the roe become the fry and they give them their first feed. A smolt is produced over a period of 12 months from fertilization of an egg to a mature smolt weighing 100-250 grams. The arrival of the roe can cause a mortality rate of about 10 percent in the early production stage. The farm has a limit of 65 to 70 kg per cubic meter. This ensures that the environment is stress free. The case fish farm Settefisk (set fish) has two hatcheries for the production of smolt. The facilities are located in Smøla and in Aure Municipality. The total annual production is 3.5-4 million smolt annually, with 75% of the volume sold externally on contracts and/or spot. The smolt produced from these facilities has a size of 150-500 grams before it is launched for the seawater.

Then the fish are transported to seawater open cages where they are grown to around 5-6 kg over a period of 24-30 months. Each cage has around 200,000 fish. A typical small size fish cage is 24000 cubic meters and a large cage is 40000 cubic meters. The growth of the fish is heavily dependent on seawater temperatures, which vary by time of year and across regions. When they reach harvestable size, the fish are transported to processing plants where they are slaughtered and gutted. Most salmon are sold gutted on ice in a box (GWT).

The total freshwater production cycle takes approximately 10-16 months and the seawater production cycle lasts around 12-24 months, giving a total cycle length of on average about 3 years. Post-smolt will normally have a longer production cycle in freshwater and a shorter production cycle in seawater depending on smolt size.

5.3. Sustainable Production with The Welfare of The Fish in Focus

farming facility (Source made by the Author of the master's thesis during her visit to the fish farm at Smøla).

The case fish farm calms that for the good fish welfare and a greener planet their ambition is to be the best.

"That is why we must constantly develop. In record time, we have created ground-breaking solutions in farming technology. This means that we produce salmon in a sustainable way, which safeguards fish welfare, the environment and with a lower climate footprint. But we don't give up there. We are always exploring new methods. All parts of production must be improved, all the time. If not, we won't be the best. Innovation and development are literally in our genetic material."

One of the things case farm are most proud of are their self-developed solutions for the aquaculture industry. It's about good fish welfare and taking care of the environment - two core values for them.

1) The floating concrete cages in the sea were closed (LINK: Fishfarminginnovation.no). Development of technology for a long-lasting and low-cost closed floating concrete cage for the aquaculture industry. Salmon lice-free, energy-efficient, and long-lasting.

2) Eines AS, a shipping corporation that provides service boats and farming technologies (LINK Eines-as.no). This shipping company is the global leader in lice removal techniques for salmon and trout that protect fish welfare. They provide mild and efficient de-lice clearance.

5.4. Vaccination for a healthy fish

Fish must be vaccinated against a wide range of common illnesses. The vaccine helps prevent the spread of bacteria, which means that antibiotics are no longer necessary. Fish vaccination is required to prevent fish from common illnesses. Antibiotics are not used because the immunization protects the fish against germs. Since 2015, Norway has reduced antibiotic use in salmon, resulting in a thriving economy and a lower risk of antibiotic resistance in people (regjeringen.no 2015). Despite the fact that the fish farm's marine biologist and quality manager contend:

Norwegian salmon is nutritious. They are inoculated against most prevalent salmon diseases while they are quite tiny and reach a length of about 15 cm. Furthermore, strong cleanliness requirements are in place to guarantee that infections in aquaculture are avoided.
Norway's salmon production has increased from 50,000 to over a million tons since the 1990s. Antibiotic use has decreased by 99 percent throughout the salmon period.

> *"The use of chemicals and antibiotics in our farmed salmon has been almost zero for many years now, although it is still a concern for some," she concludes. "Consumers can have total confidence that Norwegian salmon are a chemicals and antibiotics free, and continue to be a safe, delicious and healthy choice to eat."* Says the - The Salmon Center Molde

The Norwegian aquaculture industry uses less antibiotics than any other animal farming, and in 2020, 99 percent of Norwegian salmon have never been treated with any form of antibiotic.

["….."] The latest annual report on the use of antibiotics in Norwegian animal husbandry and food production showcases the Norwegian aquaculture industry's success in minimizing the use of antibiotics in salmon farming. Last year saw the lowest ever number of veterinary antibiotic treatment prescriptions for Norwegian aquaculture farms, 48 in total. It means that 99 percent of Norwegian farmed salmon were produced without any antibiotic treatments, and thanks to our rigorous controls, *consumers* can have total confidence Norwegian salmon is completely antibiotics free. No residues of antibiotics, medicines or illegal substances have ever been found in Norwegian salmon, according to annual studies by the Institute of Marine Research in Norway. ["….."] (Norwegian seafood Council. November 2021,).

5.5. Sustainable Fish Farming Implications and Arguments for A More Circular Economy.

The Case fish farm is taking various steps to ensure that their operation is sustainable. One of these involves using energy-saving technology, such as the RAS, which recycles water using a filter system. This method has led to increased production and safeguarded the environment. The water used for the production of fish is collected through a recirculation system that filters it and then passes it through the tanks for recycling.

The quality manager at case fish farm has noted that their sustainability efforts have led to increased costs, particularly in cleaning wastewater from their fish hatcheries. However, they have also implemented profitable technologies such as the RAS and heat pumps, which have increased production and profits while providing environmental benefits. The CEO emphasizes the importance of these technologies in maintaining a constant water supply and improving productivity. The implementation of sustainable technologies has been financially beneficial for the fish farm and has also had positive impacts on the local community and global food production. The quality manager acknowledges that there are limitations to the principle of circulation in fish farming, as not all waste can be repurposed. However, there are opportunities to improve waste management, such as utilizing salmon waste for feed or sending fish waste to suppliers for use as fertilizer.

The discussion revolves around salmon farming, a practice that does not directly affect the wild fish population. Sustainability is seen as the utilization of residual salmon products, such as sludge and feed spills, for energy or remanufacture. The CEO and the quality manager both believe in working in a sustainable manner, particularly in reusing feed and using resources for as long as possible. They prioritize social aspects, such as better working conditions and job creation, while minimizing harmful chemicals and medicines and avoiding pollution. The environment is also a priority, with a focus on minimizing the use of harmful chemicals and medicines. The economy is also a critical aspect, enabling social and environmental aspects. The prioritization of these aspects depends on the department and individual's perspective, but they agree that balancing economic, social, and environmental sustainability is essential.

Case fish farm, The CEO and the quality manager, use public incentives like grants for environmental measures to become more environmentally friendly. They invest in biogas and other sustainable practices, but they acknowledge that these may not necessarily increase value or income. Government regulations and strict production requirements prompt the industry to innovate and improve their methods. They prioritize statutory environmental measures and environmentally friendly measures, conducting cost-benefit assessments before implementation. While employees do not require incentives, some environmental measures can be costly and require funding from the public sector. They also spend on government regulations and certifications, such as the Global G.A.P, to influence farming operations, reduce chemical use, and ensure good conditions for employees and animal welfare. The case fish farm is also working on implementing the Transparency Act, promoting decent working conditions and basic human rights.

5.6. Challenges

Roe supply

When asked about the challenges faced by the case fish farm the Biologist and Quality Manager explain;

Roe supply is another challenge, as there are no circular options for packaging roe and feed. There have been discussions about using feed boxes that can be returned, but no supplier has yet found one.

"the main challenges for us are a stable supply of roe all year around. We will like to purchase the roe anytime we want and how much we want and that has been difficult for the past two years during the pandemic and due to some disease in the broodstock farm so Norway today has to import a lot of roe from Iceland because we do not produce enough ourselves. We import around 100 million roe from Iceland. And this problem has been increasing for the last few years. The vaccine is also an actually somewhat more difficult than it used to be because the producers *are having problem with the production of the vaccines. (I mean it is a lot easier if you control the whole value chain then it is easier to have control over the production and quality during the whole value chain, it is difficult to*

plan with others, added by CEO). Again, added by quality manager "because we are small and local maybe that's why it is more difficult for us."

The CEO and quality manager

The case fish farm has to deal with various obstacles when it comes to implementing the Circular Economy in the salmon farming. Some of these include technological issues, economic barriers, and packaging. The case fish farm is hemorrhaging money as it continues to lose money on implementing and upgrading solutions. The monitoring system for oxygen and monitoring costs a lot of money, and it requires constant maintenance. Energy and feed are the most costly inputs and if produced on the sea, feed costs could contribute to 40-60% of expenditures.

When it comes to packaging roe, the entire (fish eggs) must remain intact and not be crushed during the transportation process. The same goes for packaging feed. Both the feed and roe are compressed using a plastic press before they are sent to the garbage disposal facility. Some suppliers have suggested replacing the current packaging with a feed box, but they have not found one yet.

5.7. cations of circular economy in fish farming on the social and environmental aspect

Although the farm salmon population in Norway is expected to grow, certain sectors of society are still concerned about the effects of these practices on the country's ecosystem. Some of these include recreational groups, professional fishers, and sport fishers. These groups demand that the increase in aquaculture production be stopped (Ellram, 2015). These facilities are located in areas such as fjords and coastlines. The waste feed, parasites, and fish escapes that these facilities produce have negative effects on the local fish populations and the environment (Taranger et al., 2015), imply that the location of fish farms was very important in terms of their environmental impact. They found that farms near the coast are the most sustainable because of their ability to exchange water with the nearby fjord. The statement was decline by (Carroll, Fieler, Velvin and White, 2003), which analyzed the data collected from over 80 sites in Norway, showed that current speed and depth weren't good

indicators of the country' sedimentary environment's quality. But, it did find that the practice of periodically abandoning sites to allow for the recovery of farmed fish was one of the most effective ways to improve the sustainable operations of the aquaculture industry.

Marine aquaculture facilities produce a large amount of effluent, which includes waste, nutrients, and feces. These discharges can have a negative impact on the local ecosystem depending on the timescale at which they happen and the waterbody receiving them.

"The use of chemicals and antibiotics in our farmed salmon has been almost zero for many years now, although it is still a concern for some," she concludes. "Consumers can have total confidence that Norwegian salmon are a chemicals and antibiotics free, and continue to be a safe, delicious and healthy choice to eat." Says the - Salmon Center Molde

The Green Warriors of Norway (NMF, 2011), released a report about the environmental effects of North Atlantic salmon farming in Norway. It revealed that the practice has several negative effects on the environment. Some of these include escapes into the ocean, the spread of disease, the treatment of the farmed fish, and the large amount of waste that ends up in the sea.

The report conducted by (Taranger et al., 2015), It revealed that the farming of Atlantic salmon in Norway has negative effects on the environment. The study found that the introduced farmed salmon had a high risk of experiencing genetic changes. According to the report, there were around 109 marine stations in Norway that reported the presence of salmon lice from 2010 to 2013. The infections were caused by various viral diseases, such as PD, IPN and CMS.

Sea lice can kill wild salmon, which is why the escapes of infected farm fish are considered dangerous. In addition, Hydropower plants in Norway can threaten the survival of wild salmon. The plants lower water flow and increase temperature, which can cause kidney diseases to the salmon (Sterud et al., 2007).

One of the biggest concerns of the aquaculture industry is the impact of fish feed on the environment. For instance, the use of soy in dry feed has an adverse effect on local ecosystems. This industry must find ways to minimize its impact on the environment while

still maintaining the nutritional quality of the fish (TheExplorer, 2020). Companies are currently developing fish feed that is more eco-friendly. For instance, they use zooplankton that are commonly found in the oceans as their natural prey. These animals are fed algae that can absorb carbon. A scientist from Norway's Research Institute noted that a new fish feed that is made from small shrimps is currently undergoing testing.

The aquaculture industry is currently facing a major challenge due to the presence of sea lice, which are parasites that can affect the growth and quality of fish. When these eggs are released into the water, they can turn into larvae that can then attach themselves to the fish. This issue can also lead to diseases and predation. To minimize the impact of the parasites on the environment, various companies in Norway have been working on developing fish feed that is both eco-friendly and effective (TheExplorer, 2020). One of the techniques being used by companies to prevent the spread of sea lice is by using electrical pulses. This method works by inactivating the parasites before they can attach themselves to the fish. Another effective technique is by using a laser to kill the parasites by scanning the entire fish for the parasites. This method eliminates the parasites completely by destroying them one by one using a single laser. This method can be used on a continuous basis and is usually performed without moving the fish. Another effective method is by keeping a close eye on the fish and counting the number of sea lice. This method can prevent the parasites from entering the cages. The farm utilizes a closed-system aquaculture that is integrated with a major producer of salmon in Norway known as SalMar. Through the utilization of shared co-location, this project was able to address the environmental issues caused by marine aquaculture along Norway's coastline, the closed pen system prevents fish escapes and minimizes the risk of contaminating wild fish stocks. It also allows waste to be collected and disposed of properly, which significantly lowers the likelihood of sea lice outbreaks.

In 2013, Norway's fisheries authorities introduced several reforms that aim to improve the environmental impact of the country's salmon industry. One of these involves the introduction of a new license that has stricter conditions. The new license had a limit of 0.5 sea lice per fish. After a new conservative government took over in the country, the fisheries authorities decided to implement new regulations that aimed to reduce the amount of sea lice in the aquaculture industry. As a result, the average maximum amount of biomass that an individual farmer could harvest per year was increased by 5%. The goal of the new regulations was to create a more predictable and long-term growth process by implementing

a new set of growth parameters. In addition, the authorities also introduced a new green management strategy that requires the monitoring of sea lice in every farm (Hersoug, 2015), the authorities also ordered the slaughtering of all or some of the farm's salmon if they were found to have more than the required number of sea lice.

CHAPTER 6
DISCUSSION

6.0. ANALYSES OF THE EMPIRICAL FINDINGS

The implementation of SSCM practices and circular economy principles during the fish production process significantly improved the farm's environmental performance and the social well-being of the local community. Table 6.1.1. provides a summary of the farm's case.

Table 6.0.1. Implications of circular economy in fish farming on the social and environmental aspect

SCO	- Small family run and owned - Land-based smolt-producer - Frequent use of outsourcing
Challenges	- Cost - Feed - Supplier limitations - Technological issues
Sustainability	- Closed-environment - Collaboration - Information flow - Management of waste - Certifications - Input optimization - Fishtalk - RAS
Circular Economy principles	- Reuse of water - Energy-efficient heat pumps
The implications of sustainable fish farming	- Improved Fish welfare - Technological innovation - No escapes - No lice - Control of flow - Higher cost

Case Fish Farm is focused on adopting various sustainable practices in its operations. One of these is the establishment of an aquaculture system that reuses and recycles water. This

method has been instrumental in enhancing the farm's productivity. The case fish farm continuous efforts toward sustainable practices have been identified as the primary factors that have contributed to its success. One of the most prominent examples of this is the establishment of a recycling system for aquaculture. This method has helped the case fish farm improve its productivity and environmental impact. The company is also focused on implementing various energy-saving techniques such as recycling, material reduction, and reutilization. It places great importance on ensuring that the fish are well taken care of, and it prioritizes having enough space for them. Case Fish Farm is currently exploring the possibility of managing sludge and other undesirable byproducts in the context of generating biogas. Although the strategies have not yet been implemented, the potential of using the sludge from the farm for production of biogas has been identified. It can be utilized as an energy source or used as fertilizer.

The main factors that have prompted organizations to adopt sustainability measures are government incentives and environmental regulations, according to Case Fish Farm's survey respondents. However, these procedures can also be very costly and may not provide immediate returns. Case Fish Farm is currently investigating the use of biogas as a means of meeting environmental regulations. It is aware that implementing the same standards in sea-based production methods can be more challenging compared to land-based ones. This could provide the case fish farm with an advantage in this regard.

The cost of implementing CE projects is a major issue faced by Case fish farms. One of the most expensive components of their input costs is feed. They also encounter issues with the packaging of roe, which is not made from circular materials. The correct amount of feed should be balanced to prevent waste and excess feed, which can negatively affect the fish's water quality and other factors. Companies must also consider the price and quality of the feed when sourcing it.

Case fish farms have been able increase their profitability by implementing sustainable technologies, such as heat pumps and RAS. These innovations not only promote environmental sustainability, but they also help improve the living conditions of the coastal communities that they operate in. Moreover, the case fish farm has a social responsibility to the coastal communities that it serves, and the waste generated by the industry could be utilized for various purposes.

6.1. Discussion

The concept of circular economy was developed in response to the environmental impacts of the Norwegian fish farm s sustainable management practices. Some of these include the use of open systems of farming, the use of antibiotics to treat fish diseases, and the dumping of waste into the ocean. The company decided to make a positive impact on the environment and the community by implementing a closed system of aquaculture. This method allowed the farm to maintain high standards of production and contribute to the local community. New sustainable management techniques, like the utilization of renewable energy, water recirculation, and open systems, allowed the fish farm to increase the production of high-quality salmon. It also encouraged the farm to deal with waste from both the sea farm and land.

The results of the study are consistent with previous studies that indicated that the 3R principles were the most effective ways to manage waste.

The findings of this study revealed that the collaboration between the local fishery, the case fish farm, and the slaughter facility has resulted in various benefits for the local fisheries. The supply chain between the farm and the slaughter facility has also helped improve the quality of the salmon. The findings of this study are consistent with the recommendations of a report released by McKinsey in 2016, which stated that establishing collaboration among various stakeholder groups within a supply chain can contribute to economic benefits.

Through the implementation of sustainable supply chain practices, the fish farm has been able to improve its operations and become more sustainable. This finding is in line with the findings of a study conducted by Bakker et al. in 2014, which indicated that the link between sustainability and the circular economy is strong.

Table 6.1.1. shows the circular economy's various effects on the environment, social, and economic aspects

No	Aspects	Circular economy implications	Outcome
1.	**Social and Societal value**	- Collaboration with local fisheries. - Collaboration with slaughter facility. - Collaboration with local community (Trainings). - High technology	- Development of rural area - Job creation - Improved infrastructure - Nutrition food (protein) & food security - Increase fish supply reduction in fish price - Conservation of social structure - Education - Healthcare
2.	**Environmental**	- Waste collection - Water recirculation - Reduced usage of chemical - Alternative feed - Reduced escapes - Removal of sea lice	- No waste to landfill - Reduce water consumption - Preserve nature and environment - Reduce transfer of diseases and sea lice - Allowing site recovery
3.	**Economic**	- Challengeable to predict	- Extra benefits for the whole fish farming

Table 6.2.1. shows the circular economy's various effects on the environment, social, and economic. One of its main components is the contribution of the circular economy to the development of the local fisheries by allowing the case fish farm to provide the community with clean and healthy salmon. It also offers free training programs to help the public learn more about the farm's operations.

The concept of supply chain operations has been established within a case fish farm to consider the various aspects of sustainability. These findings support the notion that a

sustainable system can be achieved through the combination of economic, environmental, and social factors.

The establishment of the case fish farm in Smøla has brought about the development of this region. Currently, over 60 people work at the farm. Their employment has led to the establishment of various facilities such as supermarkets, health care, and education.

CHAPTER 7

CONCLUSIONS, LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEACH.

The chapter concludes with an overview of the findings of this master thesis, and it provides implications for practitioners and theorists. It also explores the limitations of the thesis, as well as possible future research suggestions.

7.0. CONCLUSIONS

The goal of this master thesis is to examine how the principles of circular economy can contribute to sustainable development of the supply chain management in a single case involving a Norwegian fish farm. The farm, which is located on the island of Smøla, adopted sustainable practices in the production and growing of fish. This resulted in a complete change in the way the farm operates and grows fish. The demand for food and the environmental impact of fish farming are two factors that have been considered when it comes to the development of this master thesis. The empirical case study helps to identify the main objective of the study and the various research questions that need to be answered.

Research question 1. ***How is SCM organized within the Norwegian fish farming industry***

They are mainly engaged in the production of farmed fish, and areas beyond this role are typically handled by other actors. These individuals can be involved in various aspects of the supply chain, such as the production of feed, roe, and fish smolts.

Research question 2. ***How does live fish handling contribute to making supply chain operations sustainable? is connected to sustainable practices?***

The Case Fish Farm is dedicated to fostering collaboration and communication as well as minimizing emissions and enhancing sustainable practices.

Research question 3. ***What challenges do fish farming companies face under their supply chain operations ?***

According to the study, the case Fish Farm encounters numerous challenges when it comes to managing its supply chains include the complexity of implementing technology, the need to optimize fish health, and the cost of doing business. The case fish farm can address these issues and improve their operations and sustainability by maintaining high-quality production of fish and ensuring the health of their fish.

Research question 4. How CE principles contribute to (trade off) all the three aspects of sustainability – economic, environmental and social?

The fourth research question, which focused on the impact of a circular economy on the social and environmental values of communities. Through my research, I was able to gain a deeper understanding of how a circular economy can affect the social and environmental aspects of a community. These findings can be helpful in identifying ways to implement sustainable business practices within different sectors.

The goal of this study: is to explore the effects of the Circular economy implications on sustainable supply chain management: a case study within the Norwegian fish farming industry: This is done through a single case study that focuses on the importance of ensuring that the fish are treated properly during their growth phase. The sustainable practices of fish farming can help address environmental, economic, and social issues. This can be achieved through the use of a variety of strategies, such as recycling and reusing materials, collaborating with different groups, and optimizing inputs. Through the use of digital tools, sustainable practices can be improved in Norway's fish farming industry. Communities and individuals can help the sector transition to a more sustainable way of doing business. But, this can only be done with a long-term perspective since there are no shortcuts that can guarantee quick results.

7.1. Implications for theory

The study offers valuable insights into the various practices utilized by the fish farming community. The findings support various theories, such as the use of recycle, reduce, and reuse. In addition, the study highlights the role that government regulations and subsidies play in promoting sustainability.

Moreover, the study emphasizes the significance of incorporating a holistic outlook on sustainability, which encompasses environmental, economic, and social aspects. It also argues that focusing solely on certifications and environmental issues is not an effective way to achieve sustainability. The study explores the various challenges faced by the supply chain of the fish farming industry in Norway. These include the optimization of feed and sustainability, choosing suppliers, technology issues, and managing outputs that are not ideal.

7.2. Implications for practice

The project's findings and recommendations can be utilized by other fish farmers who wish to improve their supply chains. They can be beneficial in helping them develop effective strategies and procedures to make their operations more sustainable. Governments can play a vital role in addressing sustainability by providing incentives, establishing regulations, promoting best practices. Through investigation, I was able to learn about the various steps that can be taken to improve the efficiency of the supply chains by implementing CE principles. This can help managers and practitioners improve their efficiency and reduce their environmental impact.

7.3. Limitations and suggestions for future research

A longitudinal study on the potential future developments of current innovation practises and tactics would be a useful next step in research. Will the sector become "more

sustainable"—that is, will mortality and emissions rates drop—and will this translate into increased revenues for the sector?

A longitudinal study on the potential future developments of current innovation practices and tactics would be a useful next step in research. Will the sector become "more sustainable"—that is, will mortality and emissions rates drop—and will this translate into increased revenues for the sector?

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APPENDIXES

Appendix 1: Consent letter

Do you want to participate in the master's degree study? «Circular economy implications on sustainable supply chain management within the Norwegian fish farming industry»

This is a question for you about participating in a master's degree study where the purpose is to gain knowledge about various aspects of the circular economy implications on sustainable supply chain management within the Norwegian fish farming industry. In this document, we provide you with information about the aims of the project and what participation will mean for you. First comes practical information and then finally comes a declaration of consent.

Purpose of the project

Aims to explore the implications of a circular economy on developing sustainable supply chain operations in the Norwegian fisheries while trading off 3 main sustainability pillars which are environmental protection, economic aspects, and social responsibility. In doing so, this master's thesis presents an empirical case of fish production based on Recirculating Aquaculture system for sustainable aquaculture. The technology is used to reuse the water in fish farming and to improve the overall process. The literature review has included the case study from Norway to show how sustainability and circular economy are used in fish farming in Norway and what advantages can be achieved.

Which institution is responsible for the research project?

Molde University College Specialized University in Logistics is responsible for the project (data controller).

Why are you being asked to participate?

You are invited to participate in this study on the basis of your function where you are employed and your knowledge of the topic.

1.0. What does participation involve for you?

The method in this study is interview. The interview takes approx.. 45 minutes. This interview will be recorded with an approved dictaphone. We will contact you and arrange a time that suits you.

Participation is voluntary

Participation in the project is voluntary. If you chose to participate, you can withdraw your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you chose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data

We will only use your personal data for the purpose(s) specified here and we will process your personal data in accordance with data protection legislation (the GDPR).

- Only the master's degree student will know your identity. Data processing is done by the student. The data handling plan has been approved by NSD.

What will happen to your personal data at the end of the research project?

The project is scheduled to end around 9th June 2023. At the end of the project, the data material with your personal information will be deleted.

Your rights

So long as you can be identified in the collected data, you have the right to:

- access the personal data that is being processed about you
- request that your personal data is deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and
- send a complaint to the Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?

We will process your personal data based on your consent.

Based on an agreement with Molde University College Specialized University in Logistics. The Data Protection Services of Sikt – Norwegian Agency for Shared Services in Education and Research has assessed that the processing of personal data in this project meets requirements in data protection legislation.

Where can I find out more?

If you have questions about the study, or want to know more about or exercise your rights, please contact:

- Student Mir Salim Ali, mir.s.ali@himolde.no
- Molde University College at Antonina Tsvetkova, Antonina.tsvetkova@himolde.no
- Our data protection officer: The data protection officer at Molde University College can be reached by contact: personvernombud@himolde.no

If you have questions about how data protection has been assessed in this project by Sikt, contact:

- email: (personverntjenester@sikt.no) or by telephone: +47 73 98 40 40.

With best regards,

Project Leader Student

(Supervisor)

Declaration of consent

I have received and understood information about the project «Circular economy implications on sustainable supply chain management within the Norwegian fish farming industry» and have been given the opportunity to ask questions. I give consent:

- ☐ To participate in an interview in the master's degree thesis "Circular economy implications on sustainable supply chain management within the Norwegian fish farming industry"
- ☐ that my personal data is stored until the end of the project

I give consent for my personal data to be processed until the end of the project.
dd/mm/yyyy

(Signed by project participent, date)

Appendix 2: Interview guidelines for the respondents

General Questions:

1. *Please give a brief presentation of your position in the company (project).?*
2. *What is it your duties about your position.?*
3. *How long have you worked in this position or project.?*
4. *What is it you enjoy most about your job or position.?*
5. *How old are you.?*

Operations and Logistics:

Supply Chain Management:

1. *Can you briefly explain the supply chain you have today?*
2. *Has the supply chain experienced changes in recent years?*
3. *Which parts of the supply chain do you run yourself, and which are left to other actors?*
4. *What are the challenges do you face with the Supply Chain?*

Production:

1. *What are the main challenges you face associated with fish farming?*
2. *How the production of fish farming is organized and managed - what are the stages of production process?*
3. *What are the primary logistics operations you could highlight in the production process?*
4. *How does fish stress influence the production process and how do you overcome fish stress?*
5. *What are the primary causes of fish stress in the production process and how do you monitor and identify signs of fish stress?*
6. *What strategies do you have in place to reduce fish stress in the production process?*
7. *What digital technologies are being used at NEKTON for the whole process; ie; from fish Production to all the way getting it to the end users?*

Sustainability Supply Chain Management:

1. *What are the current sustainability challenges and initiatives in Nekton and other Norwegian fish farming industry?*

2. *Does Nekton already have practices sustainable supply chain management? If yes how have Nekton is benefiting from it?*

3. *What challenges have been encountered in the implementation of sustainable supply chain management at NEKTON's fish farming?*

4. *What methods do you use to ensure the sustainability of fish farming operations?*

Circular Economy:

1. *How Circular Economy help to make fishing industry such as fish production more social, environmental and economical?*

2. *What are the main drivers of the Circular Economy at NEKTON - and what are the main challenges of implementing Circular Economy principles in the fish farming industry?*

3. *What are the main benefits of implementing Circular Economy principles in the fish farming industry?*

4. *What is the impact of Circular Economy principles on the sustainability of supply chain management at NEKTON?*

Recirculation Aquaculture System:

1. *What are the main components of a Recirculation Aquaculture System (RAS) and how do they contribute to sustainable supply chain management (SCM) at NEKTON's fish farming?*

2. *What are the main challenges and opportunities associated with implementing a (RAS) at NEKTON's fish farming?*

3. *What are the benefits of using a (RAS) at NEKTON and in the Norwegian fish farming industry in terms of sustainability and resource efficiency?*

Spawning process:

1. *What are the main processes involved in the spawning of fish – and what techniques are used to control the number of fish that are spawned?*

2. *Is there any specific technology used to facilitate the spawning process – and how do you ensure that the spawning process is safe for the fish?*

3. *How does the quality of the water affect the spawning process?*

4. *What are the potential risks associated with the spawning process?*

Smelting process:

1. *How does the smelting process work at NEKTON – and what are the key steps involved in the smelting process?*

2. *What are the benefits of the smelting process? And what challenges have you faced in implementing the smelting process at NEKTON?*

3. *What safety measures are taken to ensure the smelting process is carried out safely – and what technologies are used to ensure the smelting process is efficient and effective?*

4. *What measures are taken to ensure the smelting process is environmentally friendly – and what are the potential risks associated with the smelting process in the Norwegian fish farming industry?*

From fresh water to sea process:

1. *What are the main challenges of transitioning from fresh water to sea farming and what are the most important considerations when planning for a transition from fresh water to sea farming?*

2. *What are the key differences between fresh water and sea farming that must be taken into account during the transition?*

3. *What specific measures have been taken to ensure the safety and sustainability of the transition – and what infrastructure and technology is necessary to support the transition from fresh water to sea farming?*

4. *What are the potential risks associated with transitioning from fresh water to sea farming – and what are the best practices for ensuring the safety and sustainability of the transition?*

Slaughter and processing:

1. *What steps have been taken to ensure that the fish are slaughtered and processed in a way that is in compliance with all relevant Norwegian regulations and Norwegian animal welfare standards?*

2. *What technologies and techniques are used to ensure that the fish are slaughtered and processed in a safe and efficient manner?*

3. *What processes are in place to ensure that the fish are slaughtered and processed in a way that minimizes waste and maximizes quality?*

4. *How does NEKTON ensure that the fish are slaughtered and processed in a way that is environmentally sustainable?*

5. *How does NEKTON manage its west product after the slaughtered process is done? - How else can the west product be used?*

Critical Risk and Risk Management

1. *How do you management Outbreak of lice?*
2. *How and when does the Vaccination Process takes place?*
3. *How do you manage fish escapes?*

Others;

1. *What kind of research and development is being conducted to improve the fish farming at NEKTON and in the Norwegian fish farming industry?*
2. *Is there anything else that you think would be important for us to know?*
3. *What advice would you give to someone interested in entering the fish farming industry?*