



Norwegian University of
Science and Technology

Creating Competitive Advantage through Green Innovation

A Qualitative Study of the Norwegian
Aquaculture Industry

Frida Rotvold

Industrial Economics and Technology Management

Submission date: February 2018

Supervisor: Arild Aspelund, IØT

Norwegian University of Science and Technology

Department of Industrial Economics and Technology Management

dedication (optional)

Problem Description

This thesis aims to investigate how firms use green innovation to create competitive advantage, and how external knowledge sharing can enable green innovation processes. A brief study of the Norwegian aquaculture industry, as well as a multiple case study of firms operating in the aquaculture industry serve as the foundation for empirical data. The study is centered on the theory of innovation and knowledge sharing.

Preface

This thesis was written as the final part of my Master of Science degree in Industrial Economics and Technology Management, at the Norwegian University of Science and Technology (NTNU). The specialisation of my degree has been within Strategy and International Business Development. This thesis is based on my pre-diploma thesis on green innovation, written in collaboration with Elisabeth Våland Suhr during the fall of 2016. The aim of this study is to investigate how firms use green innovation to create competitive advantage, and in what way external knowledge sharing can enable green innovation processes. The thesis is part of the project *Sustainable Innovation and Shared Value Creation in Norwegian Industry* (SISVI) at NTNU.

First and foremost, I would like to thank my academic supervisor Professor Arild Aspelund for his valuable guidance and constructive feedback throughout the process.

I would also like to thank senior consultants in Rambøll Eskil Forås and Geir Tevasvold for guidance throughout the process. In addition, a big thank you for the help in identifying a suitable case firm, and engaging them in the study. The contributions are highly appreciated.

I would also like to thank the case firms, Måsøval, represented by CEO Asle Rønning, and Lerøy Midt, represented by Production Manager Stig Nidar Selvåg, for their valuable contributions to the empirical data.

Furthermore, I would like to thank Heidi Glørstad Nielsen in Trøndersk Kystkompetanse for an insightful conversation and relevant industry input.

Lastly, I would like to thank my boyfriend, Sebastian, and my father, Lars Aage, for support, valuable discussions and encouragement.



Frida Louise Rotvold — Oslo, 24.02.2018

Abstract

The aim of this study is to get a broader understanding of the concept of green innovation, and how firms use it to create competitive advantage. Empirical data from the Norwegian aquaculture industry is used, both through industry research and a multiple case study, to investigate the concept of green innovation. Empirical findings will be anchored in theoretical literature on green innovation and knowledge sharing in order to generalize the findings. It was discovered that the way in which firms use green innovation to create competitive advantage depends on the firm's strategy of differentiation or low cost. The findings of this thesis show that firms focusing on low cost use green innovation to come up with solutions that exploit resources more efficiently, and, hence, decrease production costs. Moreover, it was found that external knowledge sharing will help decrease the complexity of green innovations, as well as removing some of the risk and uncertainties related to whether or not the green innovation process will be a success. This study is believed to be valuable to managers of firms, both for firms that already implement green innovation processes and for firms that do not.

Summary

Målet med denne studien er å få en større forståelse av begrepet grønn innovasjon, og hvordan bedrifter bruker dette til å skape konkurransefortrinn. Empiriske data fra den norske oppdrettsnæringen er benyttet, både gjennom en litteraturstudie av industrien og ved en multipel casestudie, for å undersøke konseptet grønn innovasjon. Empiriske funn vil bli forankret i teoretisk litteratur om grønn innovasjon og kunnskapsdeling for å gjøre funnene generaliserbare. Det ble oppdaget at hvordan bedrifter bruker grønn innovasjon for å skape konkurransefortrinn er tydelig avhengig av firmaets strategi for differensiering eller lavpris. Resultatene av denne studien viser at bedrifter som fokuserer på bruker grønn innovasjon for å finne løsninger som utnytter ressurser mer effektivt og dermed reduserer produksjonskostnadene. Videre ble det funnet at ekstern kunnskapsdeling vil bidra til å redusere kompleksiteten til grønne innovasjoner, samt fjerne noe av risikoen og usikkerheten knyttet til om den grønne innovasjonsprosessen vil bli vellykket eller ikke. Denne studien antas å være verdifull for ledere av bedrifter. Både for de bedrifter som allerede implementerer grønne innovasjonsprosesser og for de som ikke gjør dette.

Table of Contents

Problem Description	i
Preface	ii
Abstract	iii
Summary	iv
Table of Contents	vii
List of Tables	ix
List of Figures	xi
Abbreviations	xii
1 Introduction	1
1.1 Background	1
1.2 Research Questions	2
1.3 Purpose and Structure	2
1.3.1 Purpose	2
1.3.2 Structure	3
2 Conceptual Background and Theoretical Framework	5
2.1 Sustainability	5
2.2 Green Innovation	6
2.2.1 The Double Externality Problem	8
2.2.2 Regulations	8
2.3 Competitive Advantage	10
2.3.1 The Resource-Based View	10
2.3.2 The Relational View	10
2.4 External Knowledge Sharing	13

2.4.1	Absorptive Capacity	13
2.5	Open Innovation	14
3	Methodology	17
3.1	Selection of Research Method	17
3.1.1	Literature Review	17
3.1.2	Research Questions	19
3.2	Industry Selection	20
3.3	Case Selection	20
3.4	Data Collection	21
3.4.1	Industry Study	22
3.4.2	In-depth Interviews	22
3.5	Data Analysis	24
3.6	Quality of Study	25
3.6.1	Validity	25
3.6.2	Reliability	26
3.7	Methodological Limitations	26
3.7.1	Limitations Regarding Research Method	26
4	Empirical Findings	29
4.1	Industry Analysis	29
4.1.1	Atlantic Salmon	30
4.1.2	Industry Development	31
4.1.3	Industry Structure	33
4.1.4	Innovations	35
4.1.5	Regulations	36
4.1.6	Risk Factors	38
4.2	Multiple Case Study	40
4.2.1	Måsøval	41
4.2.2	Lerøy Midt	46
4.3	Trøndersk Kystkompetanse	52
5	Discussion	55
5.1	Creating a Competitive Advantage	55
5.1.1	Differentiation	56
5.1.2	Lower Costs	57
5.1.3	Heterogeneity	58
5.1.4	The Role of Partners and Cooperation	59
5.2	External Knowledge Sharing	61
5.2.1	The Importance of Trust	61
5.2.2	Operating in an Open Environment	65
5.3	Implication for Managers	66
5.4	Limitations	66
5.5	Further Research	67
6	Conclusion	69

Bibliography	71
Appendix	79

List of Tables

3.1	Five-step Literature Search	18
3.2	Keyword Search Algorithm	18
4.1	Top 10 Norwegian farmers	33

List of Figures

4.1	Production areas	39
4.2	Lice and mortality costs	45
6.1	Wordcloud from interview with Måsøval	79
6.2	Wordcloud from interview with Lerøy Midt	79
6.3	RAS	84
6.4	FT System	84

Abbreviations

NOK	=	Norwegian Kroner
RBV	=	Resource-Based View
RV	=	Relational View
LSG	=	Lerøy Seafood Group
TTK	=	Trøndersk Kystkompetanse
RAS	=	Recirculating Aquaculture System
FT	=	Flow Trough

Introduction

In this chapter, the background for the thesis and research question, in addition to the study's structure will be introduced.

1.1 Background

Climate change and destruction of natural resources are some of the major challenges of our time. As a result, stricter policies and regulations have been implemented to foster strong, more sustainable and inclusive growth. This has led to new opportunities for innovation, value creation and more efficient allocation of resources. Thus, innovation has become an increasingly important way for firms to successfully compete in changing markets and environments while contributing to sustainable development (Klewitz and Hansen, 2014).

In the fall of 2016 a literature study on the concept of green innovation was conducted Rotvold and Suhr (2016). The results showed that most of the articles discovered were published within the last ten years, and the majority of them were quantitative studies. This indicates that there is still a lot of uncovered ground, especially within in-depth case studies. Moreover, it shows that green innovation is an area that is both popular and important for researchers. The research by Rotvold and Suhr (2016) concludes with the success of firms implementing green innovation being strongly dependent on green values and strategies, and the ability to draw on external capabilities. This thesis seeks to investigate how firms use green innovation to create an advantage. Further, it seeks to come with suggestions on how firms can use external knowledge sharing and open innovation as enablers for successful green innovations, and, thus, create competitive advantage.

The Norwegian aquaculture industry operates on the nature's terms, thus it includes responsibilities for the firms involved. The industry, the authorities, and the researchers have to work closely together to ensure that resources are used in a reasonable manner. Today, the aquaculture industry experience immense challenges due to external, non-controllable factors such as diseases and salmon lice. Despite a high demand for Atlantic salmon, growth in the industry has been put on hold until new solutions to cope with these chal-

allenges are found. Hence, to guarantee sustainable development, the authorities have implemented strict regulations. Because of the focus and awareness on sustainable development in the industry, in addition to strict regulations, it makes it an interesting empirical case to better understand the concept of green innovation, and answer the research questions posed in the next section.

1.2 Research Questions

To establish a better understanding of the concept of green innovation, and how it can create competitive advantage, two RQs are formulated. The first research question aims to explore the concept and how it can create competitive advantage, whereas the second is a sub-question that aims to explore the mediating function of knowledge sharing regarding green innovations. There is a disagreement among researchers whether or not green innovation can be a source of competitive advantage. It is argued that one of the greatest difficulties of green innovation is to make it a source of competitive advantage (Rennings, 2000), while others suggest that there does not have to be a trade-off between being green and being competitive (Porter and Van der Linde, 1995). It is also suggested by Rotvold and Suhr (2016) that there might be undiscovered potential for firms to create competitive advantage by going green. Though there is a lack of qualitative research in the field of green innovation. To establish a better understanding of how firms use green innovation to create competitive advantage, the following research question is posed:

RQ1: How do firms use green innovation as a strategic tool to create competitive advantage?

It is suggested by scholars that through external knowledge sharing firms can reduce the costs and risks related to innovation projects (Wong, 2013; Weng and Lin, 2011). Recent studies have shown that external collaborations may help firms recognize new uses of old technologies (Chen, Chang, and Lin, 2014; Xie et al., 2016). Hence, sharing knowledge across firm boundaries can create new resources, and, thus, generate profit for the firm. Therefore the following research question is posed:

RQ2: In what way does external knowledge sharing contribute to green innovation processes?

To answer these questions, a case study will be performed on two Norwegian firms in the aquaculture industry; Måsøval and Lerøy Midt. The case firms are chosen due to their strategies towards sustainability, their internal innovation activities, and the belief that they are creating a value for the firm by doing so.

1.3 Purpose and Structure

1.3.1 Purpose

More and more firms are becoming aware of the environmental impact of their activities. Additionally, stakeholders have higher demands regarding sustainability in the product

they buy, and in the value chain of partners. Nonetheless, regulations force firms to take on sustainable activities. Thus, the purpose of this study is to investigate how firms use green innovation to create competitive advantage, and how external knowledge sharing in an open environment can contribute to this matter.

1.3.2 Structure

This thesis is structured as follows. The following chapter provides an introduction of the conceptual background and theoretical framework of the thesis. This includes sustainability, green innovation, theories of competitive advantage, theories of external knowledge sharing, and the concept of open innovation. Chapter 3 will describe the methodology of the thesis, including research method, case selection, data selection, data analysis, as well as discuss the quality of the research design and methodological limitations. Chapter 4 will present the empirical data from the industry analysis, the in-depth interview with the case firms, as well as an interview with Trøndersk Kystkompetanse. Chapter 5 discusses the findings of the study. This discussion will look at relevant empirical findings as well as previous research done on the field, additionally implications for managers will be discussed. Then, limitations of the study and opportunities for further research are presented. Lastly, Chapter 6 will provide a conclusion of the thesis.

Conceptual Background and Theoretical Framework

To give a better understanding of the concept of green innovation a conceptual background is presented. Moreover, a theoretical framework will together with the conceptual background assist in answering the research questions¹. The structure of this chapter is as follows: First, the background on sustainability is presented. Next, the concept of green innovation is explained as well as the difference between green and ordinary innovation. These first two sections form the conceptual background. Thereafter, the theoretical framework is presented by explaining the theory of competitive advantage through the Resource-Based View and the Relational View. Then, theories of external knowledge sharing and open innovation are presented.

2.1 Sustainability

In 1987, the United Nations proposed a strategy for achieving sustainable developments through Our Common Future, also known as the Brundtland Report (WCED, 1987). Sustainable development is defined by WCED (1987) as: "...development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (p. 8). This became the start of an environmental shift followed by Earth Summit in 1992, which resulted in Agenda 21 and the Rio Declaration and led to the establishment of the Commission on Sustainable Development (UN, 1992). This was an establishment to call for partnerships between business and environmental groups. The period post-Rio was seen as a turning point in the relationship between corporate business and the environment (Redclift, 2005).

In 1997, the Kyoto Protocol was adopted, and in 2005, it took effect. Its function is to commit industrialized countries to stabilize greenhouse gas emissions based on the

¹RQ1: How do firms use green innovation as a strategic tool to create competitive advantage? RQ2: In what way does external knowledge sharing contribute to green innovation processes?

principles of the convention. The Kyoto Protocol presents two main elements. The first is a binding emission reduction commitment for developed countries. The second is the establishment of flexible market mechanisms based on the trade of emission permits. The Kyoto Protocol has been the only legally binding international instrument (UN, 2016b). On the 4th of November 2016, the Paris Agreement entered into force (UN, 2016a), which sets out a global action plan to limit the global warming to well below 2 degrees Celsius. Moreover, the UN (2015) has declared a selection of 17 global goals² that will enhance sustainable global development. Thus, each goal has a specific target to be achieved by 2030.

Following these directives, researchers have seen the need to study the concept of sustainability. Elkington (2002) delivered the now widespread idea of the triple P bottom line for sustainable development. The three Ps stand for profit, people, and planet, and the theory suggests that a firm must produce a triple bottom line to take account of all costs included in its business. In other words, harmonize the three core elements: economic growth, social inclusion, and environmental protection.

Porter et al. (2011) argue that the purpose of the firm should be shared value creation. They define shared value as: "...the policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which they operate" (p. 6).

In other words, shared value focuses on identifying and expanding the connections between societal and economic progress. They propose three ways that a firm can create shared value opportunities: by reconceiving products and markets; by redefining products in the value chain; and by enabling local cluster development. In addition, they argue that governments need to develop regulations that enable shared value rather than work against it. By having a shared value state of mind, firms will look at new approaches to generate growth through innovations that also benefit society.

2.2 Green Innovation

As discussed in the section above, industries are experiencing increased environmental pressure, and the Brundtland Report (WCED, 1987) asserts the importance of firms to create, redesign, adapt and diffuse environmentally sound technologies. Innovation has become an increasingly important way for firms to successfully compete in changing markets and environments while contributing to sustainable development (Klewitz and Hansen, 2014).

The third edition of the OECD and Eurostat (2005) defines innovation as: "...the implementation of a new or significantly improved product (good or service) or process, a new marketing method or a new organizational method in business practices, workplace organization or external relations" (p. 11). Furthermore, the OECD and Eurostat (2005) states that innovation provides the foundation for new businesses, new jobs, and productivity growth, and is an important driver of economic growth and development.

An innovation can be classified according to the degree of change it makes. It can be either incremental; a series of many small improvements or simple adjustments in current

²An overview of the UN Sustainable Development Goals can be found in Appendix B.

technology, or radical; fundamental changes that represent a revolutionary change in technology, clearly departing from existing practices (Dewar and Dutton, 1986). Keizer and Halman (2007) suggest that:

“Radical and incremental innovation projects differ on different project dimensions. Radical innovation life cycles are longer, more unpredictable, have more stops and starts, are more context-dependent in that strategic considerations can accelerate, retard or terminate progress, and more often include cross-functional and or cross-unit teamwork. Incremental projects are more linear and predictable, with fewer resource uncertainties, including simpler collaboration relationships.” (p.30)

Further, managerial attitudes toward change and technical knowledge resources have been expected to facilitate radical innovations (Dewar and Dutton, 1986), whereas structural complexity and decentralization lead to incremental innovations (Ettlie et al., 1984). Bartlett and Trifilova (2010) find in their research that incremental innovations are an important part of the transition to green manufacturing in addition to more radical innovation. They observe that incremental innovations often arise from technical issues or problems located within particular fields of the firm, whereas radical innovation arises from more creative design processes.

Chen et al. (2012) divide green innovations into proactive and reactive innovations. The study defines the concepts as follows: “Proactive green innovation is defined as active environment-related innovation in order to take initiatives, new practices or products ahead of competitors, to decrease cost, to seize opportunities, to lead in the market, or to obtain competitive advantages” (p.387), and “Reactive green innovation is defined as passive environment-related innovation in order to comply with environmental regulations, to adapt to stakeholders’ requests, to react to the changing environment, or to respond to competitors’ challenges” (p.388). The study argues that proactive green innovation is more beneficial for firms than reactive green innovation. The findings of Chen et al. (2012) show that only internal factors such as environmental leadership, environmental culture, and environmental capability foster proactive green innovations, whereas reactive innovations arise from internal factors as well as external factors such as environmentalism and regulations. Chen et al. (2012) suggest that firms should focus on investing in the internal factors as this will cultivate proactive innovation.

Scholars are using the terms green innovation, eco-innovation, environmental innovation and sustainable innovation interchangeably (Schiederig et al., 2012). Although these terms have many similarities, minor differences between the four have been identified. The most important is the social aspect only denoted to the term sustainable innovation (Schiederig et al., 2012). This paper will use only the term green innovation.

Green innovation is a relatively new concept. The term has no general accepted definition, though the definition by Kemp and Pearson (2007) is used in this thesis:

“The production, assimilation or exploitation of a product, product process, service or management or business method that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives” (p. 7).

Despite the growing public and academic interest, there is still a debate on whether green innovation is profitable or not. Porter and Van der Linde (1995) argue that there does not have to be a trade-off between being green and being competitive. They suggest that firms should implement green innovation to use resources more productively. This can help firms achieve better product quality and enhanced global competitiveness. They draw attention to pollution as a form of economic waste, and that it is a sign that resources have been used inefficiently. As Porter and Van der Linde (1995) states, investing resources in green process innovations can minimize waste from production and enhance resource efficiency. Additionally, if the firm manages to reach and satisfy its stakeholders, competitive advantage can be achieved (Chen, 2008).

2.2.1 The Double Externality Problem

It has been argued that the main difference between green innovation and traditional innovation is the double externality problem (Rennings, 2000) and the role of regulations (Jaffe and Palmer, 1997). Green innovations can produce positive spillovers in both the innovation and diffusion phase. When referring to spillovers in the diffusion phase, these appear due to a smaller amount of external costs compared to competing goods and services. Spillovers in the diffusion phase distinguish green innovations from ordinary innovations. Rennings (2000) call this the double externality problem. In other words, this implies that the innovator improves the quality of the environment, where the society as a whole benefits from the innovation. Though, the costs are borne by the innovator alone (Beise and Rennings, 2005). Rennings (2000) argues that the double externality problem reduces firms incentives to invest in green innovations. As a result of the double externality problem, Rennings (2000) suggest that technological development (technology push) and demand factors (market pull) will not alone be strong enough incentives to invest in green innovations. This indicates that there is a need for regulations that either punish environmental harmful impacts by firms or reward environmental improvements. Therefore, regulatory push or pull is needed. Cleff and Rennings (2000) differentiate between green process innovations and green product innovations. They state that green product innovations are driven by market pull effects, whereas green process innovations are driven by regulatory push/pull effects. This thesis will mainly focus on green process innovation.

2.2.2 Regulations

Porter and Van der Linde (1995) underline the importance of regulation when it comes to green innovation. They argue that a regulatory push will cause firms to pick up on profitable opportunities. They further state that the world economies are changing, especially concerning the relationship between competitiveness and the environment. Traditionally, certain nations had a competitive advantage over others as a result of access to low-cost inputs such as capital, labor, energy and raw material. Today, rapidly emerging technologies can offset the advantages in the cost of inputs. Hence, resources are not enough to be competitive. Using resources efficiently is more important. Porter and Van der Linde (1995) suggest that regulations can help firms make better decisions in the innovation process. This can be done by having regulations that indicate likely resource inefficiencies

and potential technological improvements. Porter and Van der Linde (1995) consider incomplete information and high barriers to change some of the main reasons why firms are not seizing the opportunities of green innovation.

While most researchers agree that environmental regulations are one of the major drivers of green innovation (Aguilera-Caracuel and Ortiz-de Mandojana, 2013; Dangelico and Pujari, 2010; Lin et al., 2014; Bar, 2015; Wong, 2013; Woo et al., 2014), the degree to which it influences the successful implementation and performance of green innovation is uncertain. Dangelico and Pujari (2010) discovered that regulations present opportunities for risk minimization, image protection, preservation of revenue, and new business opportunities. This is in line with Porter and Van der Linde's (1995) theories. Aguilera-Caracuel and Ortiz-de Mandojana (2013), on the other hand, discovered a negative relationship between strict regulations and firms' financial performance. They argue that this is because the high stringency of regulations makes it hard for firms to differentiate themselves from competitors. They further state that fewer regulations, firms can be more innovative, giving them a competitive advantage due to green innovation. However, they also found that environmental regulations make firms incorporate environmental management and policies to obtain the license to operate. The same was found by Bar (2015) in the fish processing equipment industry, which, due to low margins, must be forced by regulation and fines to prioritize going green. He highlights regulations and cost reduction as the only drivers for green innovation in this industry.

Lin et al. (2014) discuss that though regulations remain one of the main drivers of green innovation, it may lead to defensive green strategies rather than more proactive ones. Wong (2013), who argues that policies and regulations that give incentives rather than constraints are usually more enforceable and will receive more acceptance from firms. De Marchi and Grandinetti (2013) draw attention to green innovators having lower levels of internal R&D investment, but significantly higher levels of external R&D investments. Jakobsen and Clausen (2016) present a difference between empirical studies undertaken in Italy and Spain versus studies originating in Germany and France, where those from Italy and Spain suggest a positive correlation between internal R&D and green innovation, whereas studies from Germany and France find that internal R&D negatively affect green innovations. Jakobsen and Clausen (2016) suggest that, since Germany and France are stricter regulated, there might be a negative correlation between regulation and internal R&D. This may further indicate that the green innovation process may be more complex and challenging than ordinary innovation and that the emphasis on external knowledge in green innovation processes acts as a substitute for internal knowledge. Thus, this indicates national differences based on environmental regulations. Hence, stricter environmental regulations motivate a more open innovation process.

Porter and Van der Linde (1995) suggest establishing relationships between firms and regulators to enhance the communication between the parties. This will improve regulators' insight as to what type of regulations may be needed in order to facilitate green innovation. Wong (2013) suggests that policymakers should use "...knowledge-based incentives such as industry-specific qualifications, certifications or special licenses in their regulation or policy design" (p.334). Fernando et al. (2016) support this by suggesting the government should provide a green technology infrastructure in addition to grants and regulations. Examples are shared labs and studios to decrease investment costs for firms, and periodical seminars and workshops to facilitate knowledge sharing. This will raise the

level of expertise in the industry through collaboration.

2.3 Competitive Advantage

Porter's theory (1986) highlight the importance for a firm to create a unique competitive position in the market. Two sources of competitive advantage are presented: differentiation and low cost. Porter and Millar (1985) state that competitive advantage in either cost or differentiation is a function of a firm's value chain. In their view, a firm's cost position reflects the shared cost of performing all its value activities relative to competitors, whereas each value activity has cost drivers that determine the potential sources of a cost advantage. Similarly, a firm's ability to differentiate itself reflects the contribution of each value activity toward fulfillment of buyer needs. Porter and Millar (1985) further state that every value activity has both a physical and an information-processing element. The physical element includes all the physical tasks required to perform the activity. The information-processing element encompasses the steps required to explore, exploit, and share the data necessary to perform the activity.

2.3.1 The Resource-Based View

The resource-based view tries to explain how firms can use internal resources and capabilities to achieve competitive advantage. The resource-based view claims that a firm's success depends upon its resource base, and whether or not the resources are valuable and non-substitutable Hart (1995). Further, to create competitive advantage, resources must be rare and hard to imitate by competitors. Resources that are hard to imitate are often tacit or socially complex Teece (1986). It is also argued that inputs, such as products bought from a supplier, cannot be a source of advantage because these input factors are either available to all competing firms or the cost of buying the product is equal to the economic value it creates (Barney, 1986). A firm's resources can be both tangible (e.g., financial reserves) and intangible (e.g., reputation) assets as well as employees' skills and social processes (Hart, 1995). This thesis will mainly focus on knowledge as a resource for the firm to answer the second research question³.

2.3.2 The Relational View

Dyer and Singh (1998) present the relational view of strategic management. As opposed to the resource-based view, where firms should protect rather than share, the relational view argues that a firm's critical resources may extend beyond firm boundaries, and considers a strategy to systematically share valuable knowledge with partners in return for access to the partner's valuable knowledge. The relational view encourages firms to increase their dependence on a smaller number of suppliers, thus increasing the incentives of suppliers to share knowledge and invest in relation-specific assets (Dyer and Singh, 1998). Though, human behavior can be unpredictable and opportunistic. To protect against opportunism, firms or transactors can use governance structures, also called safeguards. A safeguard can

³RQ2: In what way does external knowledge sharing contribute to green innovation processes?

be defined as; “a control mechanism which has the objective of bringing about the perception of fairness or equity among transactors.” (Dyer, 1997, p. 537). There are two types of safeguards used by alliance partners: third-party enforcement of agreements (e.g. legal contracts) and self-enforcing agreements (e.g relational trust) (Dyer and Singh, 1998). Self-enforcing agreements are often socially complex and hence difficult to imitate. Effective governance is the ability to employ self-enforcement governance rather than third-party governance mechanisms. Further, Dyer (1997) suggest that a transactors’ choice of safeguards will influence the incentives to engage in value creation initiatives. Dyer and Singh (1998) suggest that the competitive advantage of relationships can be divided into the following four relational rents (p.662):

1. relation-specific assets
2. knowledge-sharing routines
3. complementary resources and capabilities
4. effective governance

Relational rents are defined as ”a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners” (Dyer and Singh, 1998, p. 662). Relation-specific assets are assets that are specialized in association with the assets of an alliance partner. Such assets can create complex interfirm structures that are hard for competitors to imitate. Further, the value chain is characterized as a complex chain of input-output relations, and it often consists of individual firms that engage in a narrow range of activities (Dyer, 1997). When firms make relation-specific investments, they gain productivity in their network (Williamson, 1989). Firms who are willing to make relation-specific investments and combine resources in unique ways, may gain an advantage over firms who are unable or unwilling to do so (Dyer and Singh, 1998).

Transaction Costs

In transaction cost theories, firms are viewed as governance structures, where the transaction costs define the boundaries of the firm (Hollensen, 2008). Transaction costs are seen as the sum of the information processing necessary to coordinate the tasks of machines and people that operate the main processes within a firm. When added to the production costs, these costs make up the total costs for a firm (Hollensen, 2008).

Transaction cost theory is based on that costs arise when you perform a particular activity. According to Williamson (1989), a firm can choose between two strategies regarding transactions; integrate vertically through internalization or outsource activities through externalization. The strategy that is associated with the lowest transaction costs will be preferred. Further, the choice of transaction will rely on three variables: frequency⁴, uncertainty⁵, and asset specificity⁶. It is argued that the more specialized the assets, the higher

⁴frequency is explained as how often such a transaction is made.

⁵This can be uncertainty regarding long term relationships, close relationships, and lack of trust.

⁶Asset specificity is how unique the component is for your needs.

transaction costs due to importance to protect against opportunistic behavior (Williamson, 1989). It is further stated that transaction costs are exposed to bounded rationality⁷ and opportunism⁸. To protect against these two factors, firms can use control mechanisms such as safe guards. However, Dyer (1997) findings suggest that firms can achieve both high asset specificity and low transaction costs. He suggests that if firms understand how such a condition is achieved, it can be an important source of competitive advantage. Noteboom (2002) underlines the paradox of flexibility and transaction specificity when it comes to innovation. Transaction specificity often involves third-party governance structures. In innovation processes, specific investments might be crucial in creating mutual understanding, though the outcome is uncertain, and, hence, it would be favorable to have flexibility and not third-party governance structures that might lead to lock-in effects. Exchange of resources across firm boundaries creates the risk of knowledge spillovers to competitors. This might weaken the competitive position of the firm. Another risk is dependence, whereas firms can be locked in a relationship due to high switching costs (Noteboom, 2002).

Trust

Noteboom (2002) defines trust as follows: "'Real' trust, or trust in the strong sense, is an expectation that things or people will not fail us, or the neglect or lack of awareness of the possibility of failure, even if there are perceived opportunities and incentives for it." (p. 48). The economic value of trust lies in the fact that it enables interaction between people and firms, and that it can reduce transaction costs. Trust can be used as an instrument to decrease transaction costs in two ways:

1. Select a partner based on ex-ante trust, or from a known community.
2. Design a relation and build up trust in the process.

The downside of trust is that it entails risk and can be betrayed, which may endanger the survival of the firm. The study by Dyer (1997) suggests that the transaction costs lower as the degree of trustworthiness rise. The trustworthiness increases with the following behavior of the transactors (p.550):

1. Demonstrate through behavior a commitment to future interaction.
2. Increase the amount of information sharing.
3. Employ self-enforcing safeguards to govern the relationship.

In turn, trust can motivate transactors to invest in relation-specific assets (Dyer, 1997).

⁷Bounded rationality is our limited capacity to understand business situations, which limits the factors we consider in the decision.

⁸Opportunism are actions taken in an individual's best interests, which can create uncertainty in dealings and mistrust between parties.

2.4 External Knowledge Sharing

Knowledge is known as a critical resource for innovation (Nonaka, 2000; Adams et al., 1998; Inkpen and Tsang, 2005; Li and Calantone, 1998) and competitive advantage (Quinn, 1992; Doz, 1996; Teece, 1998). Successful firms not only create knowledge within firms' boundaries but manage to expose themselves to draw on external knowledge from other firms through alliances (Lavie, 2006; Dyer and Singh, 1998). Knowledge transfer is the process through which one unit (e.g., firm, group, department, or division) is affected by the experience of another (Argote and Ingram, 2000).

It can be drawn a distinction between two types of knowledge: explicit and tacit knowledge (Polanyi, 1966; Nonaka, 2000). Explicit knowledge refers to knowledge that is transmittable in formal systematic language, whereas tacit knowledge has a personal quality which makes it hard to formalize and communicate. Tacit knowledge is deeply rooted in action, commitment, and involvement in a specific context (Polanyi, 1966; Nonaka, 2000). Knowledge-sharing routines can enhance innovation and development of new technologies through interfirm learning. Tacit knowledge is often harder to imitate and transfer because of its complex nature. Thus, when alliances succeed in transferring tacit knowledge, they are more likely to achieve competitive advantage due to the incapability of competitors to imitate this process (Dyer and Singh, 1998). Complementary resources and capabilities are linked to that firms are able to identify and evaluate potential complementarities among alliances, and use these to access benefits that could not be accessed by the firms alone or bought in the market (e.g., reputation).

Jakobsen and Clausen (2016) add external knowledge sharing as an important input factor for green innovations in addition to those presented by Rennings (2000)⁹. In their research, they argue that the complex nature of green innovations makes cooperation and external knowledge sourcing important factors. The study by De Marchi and Grandinetti (2013) also suggest that external knowledge sharing and cooperation are important factors in the development of green innovations. They suggest that green innovative firms should rely on universities, intermediaries, and research centers as they may provide new knowledge otherwise unavailable to the firm, which can move industry and research closer. Abdullah et al. (2016) also stress the importance of access to knowledge of previously achieved practices to be able to learn from others failures and success. They argue that access to such knowledge will decrease the uncertainty and risk related to innovation projects. Hence, external knowledge sharing can decrease the barrier to implement green innovation. Fernando et al. (2016) suggest that firms should involve suppliers in collaborative activities to integrate green solutions. This involvement is also important for sharing knowledge. This is critical as suppliers are central in operations, and hence provide better calculations of resources needed and save costs.

2.4.1 Absorptive Capacity

Cohen and Levinthal (2000) underline the importance of prior related knowledge in a firm to have the ability to assimilate and use new knowledge. The ability of a firm to recognize

⁹Rennings (2000) presents in section 2.2.2 three important factors for green innovations: Market pull, technology push and regulatory push/pull.

the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities (Cohen and Levinthal, 2000). This is named a firm's "absorptive capacity". Absorptive capacity is important when there exist cognitive distance between units. The greater the cognitive distance, the more difficult it is to cross it and understand the actions and expressions of a partner. Hence, absorptive capacity help in crossing cognitive distance. Though, increased cognitive distance has a positive effect on learning by interaction (Noteboom, 2002). The development and course chosen by a firm will influence its organizational focus. The positive spillover from this peculiarity is that firms develop different technological environments, where they operate at a cognitive distance. Hence, there is resource heterogeneity between firms (Noteboom, 2002). Noteboom (2002) propose that "when people with different knowledge and perspectives interact, they stimulate and help each other to stretch their knowledge for their purpose of bridging and connecting diverse knowledge" (p. 1017). Thus, cognitive distance gives the possibility for firms to combine complementary resources. If no cognitive distance exists, it may "take out the innovative steam from collaboration" (Nooteboom et al., 2007, p. 1017). This indicates the importance of finding partners that are at a sufficient cognitive distance to learn, but without losing the sense of mutual understanding.

2.5 Open Innovation

Galia et al. (2015) observe that the share of external sources through openness is important for green innovation, the reason being that openness permits better sharing of knowledge. Ghisetti et al. (2015) propose two arguments for green innovations in an open environment. On the one hand, green innovations require broad knowledge from different actors. E.g. scientific knowledge about materials from universities and research institutes, environmental standards from specific agencies, and availability of sustainable production inputs. These knowledge requirements are difficult for firms to satisfy and are also hard to find in only one or a few external knowledge sources. The other argument is that green innovation requires the firm to combine multiple objectives to find and manage suitable compromises when it comes to production efficiency, product quality, and environmental standards. Galia et al. (2015) results show that R&D investments had no significant impact on green innovations. They also observed that sharing external sources trough openness is significantly important for green innovations. Firms that are internally oriented rather than open, shows a more reactive behavior regarding green innovations.

For innovation in general, scholars are increasingly suggesting a more external form of innovation focused on openness, collaboration and being geographically dispersed (Global Innovation Index, 2016). Chesbrough (2003) presents the open innovation model, which recommends enterprises draw on both external and internal ideas and paths to the market, to discover and develop innovative opportunities. Moreover, he suggests that we are witnessing a paradigm shift in how firms commercialize knowledge, from closed to open (Chesbrough, 2004). Chesbrough (2012) predicts that the future of open innovation will be more extensive, collaborative and engaging a wider variety of participants. Bogers (2011) states that firms have started to open their boundaries to tap knowledge from the outside and to use the market as an extension of the firm. Lichtenthaler (2011) states that, for many firms, the need to open up will most likely intensify in the future. To succeed with

an open innovation model, it will be critical for firms to develop organizational capabilities to manage open innovation processes (Lichtenthaler, 2011).

Methodology

This chapter presents the methodology of this thesis. The aim is to show and justify the choices and assumptions that have been taken throughout the research. The first section of this chapter will explain and account for the chosen research method. Further, the criteria for industry and case selection are reasoned. Thereafter, the method for collecting data will be presented, followed by the method used for analyzing the data will be explained. Lastly, an evaluation of the quality of the study and methodological limitations will be discussed.

3.1 Selection of Research Method

In this section, the selection of research method will be presented in detail. First, the search algorithm for the literature review will be explained. This is to show the reader the literature that has been used to establish a foundation for this thesis and the research questions posed. Thus, the research method is selected based on these premises.

3.1.1 Literature Review

During fall 2016, relevant existing literature on green innovation was conducted in a literature review (Rotvold and Suhr, 2016) to create a theoretical basis for the concept of green innovation. Moreover, it gave an understanding of what was already known, and, hence, enabling for the researcher to link the research questions of this thesis to the existing literature.

For the literature review, data were collected from the Scopus and Google Scholar databases in September and November 2016. To keep the study time-independent, no limit was put on publication year. As suggested by Webster and Watson (2002), it was chosen to search by topic, and not research journal or author, to include the variety of literature available in the field. The total data set includes 38 publications, all of which are empirical articles from renowned journals.

	Steps	Number of Articles
Step 1	Development of keyword search algorithm.	0
Step 2	Scopus search.	48
Step 3	Manual elimination of conceptual and irrelevant publications.	32
Step 4	Manual search by the number of citations in Scopus and Google Scholar.	38
Step 5	Analysis of the sample based on six criteria.	38

Table 3.1: Five-step Literature Search

A five-step procedure was used to identify and validate current literature on green innovation. The steps and number of articles are shown in Table 3.1. In step 1 a search algorithm was prepared for use in the Scopus database. In addition to searching for green innovation, limiting keywords were added to eliminate irrelevant literature. A specific measure taken was to eliminate studies on chemical compounds. In addition, the author wanted to look specifically at firms’ activities in implementing green innovation and therefore included the keywords process or activities in the algorithm. Lastly, the search was limited to the “Business, Management and Accounting” fields as it looks at green innovation from an innovation management perspective. The final search algorithm can be found in Table 3.2.

Keyword Search Algorithm
 (TITLE (green innovation) AND
 ABS (process OR activities) AND NOT ABS (chemical)) AND
 (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SUBJAREA , "BUSI"))

Table 3.2: Keyword Search Algorithm

Step 2 was to perform the search in the Scopus database. This search was performed twice, in September and November 2016, to include as recent publications as possible. The search resulted in 48 articles. Through step 3 all conceptual articles and articles from irrelevant research fields were eliminated. These eliminations included the fields of logistics, construction and information technology. After the elimination, 32 articles were left. In step 4 an additional search was performed to include articles that were not included in the initial search. This was done by using the search string ‘green innovation’ in Scopus and Google Scholar and sorting by the number of citations. Articles were then selected manually by relevance to the study. The additional search added another six articles, resulting in a total of 38. Lastly, step 5 seeks to validate the selected sample.¹

An alternative method could have been to use a more open search algorithm, using only the keyword green innovation. Though this could have given an even more comprehensive overview of the literature, it would result in an unmanageable amount of articles. A brief test of this method resulted in 3 812 articles, and 770 articles when limited to the “Business, Management, and Accounting” fields. This would result in a very inefficient method, and require a large amount of manual elimination of articles. We did, however, partly do this through the additional manual search, though only including the most cited

¹A table with the selected sample is to be found in Appendix B.

publications. It is believed that the sample chosen gives a sufficient overview of the major trends in current green innovation research.

3.1.2 Research Questions

Based on the findings in the literature review and dialogue with supervisor Arild Aspelund and sub-supervisors in Rambøll, the following research questions were formed:

RQ1: *How do firms use green innovation as a strategic tool to create competitive advantage?*

RQ2: *In what way does external knowledge sharing contribute to green innovation processes, and how can it be used as a strategic tool to create competitive advantage?*

Yin (2017) suggest that when deciding on research method, type of research questions posed is the most important condition, along with the level of control it has over behavioral events and the importance of current or historical events. The research questions in this thesis are of the type “how” and are therefore hard to quantify in a satisfying manner. Additionally, behavioral events cannot be controlled in answering the research questions. Hence, it has been chosen to answer the research questions through a qualitative approach. The study must, therefore, look at both prior and contemporary events. This gives the opportunity to use a large variety of source data such as observation, in-depth interviews, documents, and reports. The possibility to work with a variety of sources is one of the greatest strengths of case study research.

The core of qualitative research methods is how individuals understand the social world and the interactions between them (Bryman, 2016). The qualitative research method is often used when there is a small set of data and many different variables (Yin, 2017). Qualitative research methods focus on an inductive view of the relation between theory and research, where the generation of theories are emphasized. Though, in this thesis, an abductive view has been used, which means continuously shifting between theory and research, and not emphasizing one. The abductive view often starts with an observation or phenomenon done by the researcher that deviate from the researcher’s prior knowledge. Thus, the researcher tries to understand this observation by grounding it in theory. This opens up for new insight and concepts that need to be made comprehensible by the researcher. Hence, the abductive view does not follow a settled path but tries to explain the observations made by the researcher (Jacobsen, 2016). An open approach through semi-structured interviews has been chosen due to the findings in the literature review stating that the term green innovation is a new concept and has not been conceptualized properly yet. When researching concepts that are new and vague an abductive view with an open process is recommended (Kvale and Brinkmann, 2017; Jacobsen, 2016). To be able to constitute patterns and give the study analytically strength, a multiple case study design was chosen rather than a single case study. In single-case designs the researcher put all resources in one case, placing themselves in a vulnerable position. If the researcher has the resources available to carry out a multiple-case study, this is better (Yin, 2017). Bryman (2016) states that the main argument for favoring multiple case study is that it improves theory building. This is by Bryman (2016) explained by citing Eisenhardt (1989) and Yin (2009); “By comparing two or more cases the researcher is in a better position to establish

the circumstances in which a theory will and will not hold” (p. 67). Additionally, It is argued that researching multiple cases is often considered more compelling than single case studies, hence making the research more robust (Yin, 2017). The two cases were selected based on similarity rather than difference, with the aim to find characteristics that may show supporting or contrasting conclusions. At the same time, the opportunity for the findings to be results of an unusual or extreme case is avoided. It is acknowledged that a multiple case study is resource demanding in terms of data collection and performing analysis and thus more time-consuming. Despite the time limit of 22 weeks and the labor constraint due to there only being one researcher, a multiple case study was selected.

3.2 Industry Selection

When selecting an industry for the study, it was important that it was suitable for answering the proposed research questions. Hence, a list of criteria was developed to allow for a structured review. These criteria are presented below. The industry should:

- Be a Norwegian industry.
- Have a high focus on sustainability.
- Be regulated by the government.
- Have a high degree of research and innovation activities.
- Have a potential for growth.

Since this thesis is written as part of the SISVI project, which looks at sustainable innovation and shared value creation in Norwegian industry, the case should preferably be Norwegian. To answer the research questions, it was of importance that the industry has a focus on sustainable development. Moreover, the theoretical background called for an industry that is regulated. Also, to investigate the research questions, the industry needs to perform innovative activities. Nonetheless, there must be a potential and motivation for growth. The Norwegian aquaculture industry met all requirements and was chosen as the industry for the study.

3.3 Case Selection

The case firms were selected based on their relation to the research questions and the belief that the qualitative data could answer these questions. To answer the research questions, it was of importance that the cases had sustainability as core strategy and values. Additionally, the case firms need to be involved in innovation activities. It was also of importance that the cases were more or less similar to satisfy the case design chosen. Hence, both had to be Norwegian salmon farmers with similar activities. The criteria for case selection are listed below.

- Firms in the Norwegian aquaculture industry.

- Established in Norway.
- Established in the same region.
- Similar operations.
- Similar innovation activities.
- High focus on sustainability.
- Ambition to grow.

Additionally, the research was limited to selecting firms that were available for in-depth interviews during the master thesis period of 22 weeks from October 2017 to February 2018. The initial selection included searching the Internet, using Google, to find cases that had links to the research questions. As the salmon farming industry in Norway is highly regulated and, therefore, required to meet the demands for sustainable development, it was not hard finding cases with strategies and values including sustainability. To narrow the alternatives, it was decided, in dialogue with academic supervisor Arild Aspelund and Rambøll, that firms involved in developing Post-smolt would be favored. This enabled preservation for similarity between the two cases, in addition to being an innovation of interest for the industry. Rambøll arranged a meeting with CEO Asle Rønning in the fish farming firm Måsøval. Rambøll had an ongoing project with the firm, and know Asle Rønning well. Måsøval agreed to participate in the study. As Måsøval is part of the cluster Havbruk midt, it would be favorable that both cases were from the same cluster to simulate similarity. Thus, a Google form was sent out to participants on the Brohode conference at Frøya with a project description to interest actors in the industry to engage in the thesis. Dialogue with the Coordinator of NTNU Ocean Science and Technology, Alexandra Neyts, resulted in five contacts from the cluster Havbruk Midt that could be interesting for this thesis. Project Manager in Trøndersk Kystkompetanse (TTK), Heidi Glørstad Nielsen was one of these. An direct mail was sent to her with a description of the thesis and the requirements for the case selection. She further suggested twelve different firms that could be of interest. Lerøy Midt was one of her recommendations and met the requirements for the case selection. Production manager in Lerøy Midt, Stig Nidar Selvåg was contacted by direct mail, and agreed to participate in the study.

3.4 Data Collection

This section will present how the data for this thesis has been collected. A variety of sources have been used to find converging lines of inquiry and, hence, increase the reliability of the study (Yin, 2017). First, the data collected for the industry study will be presented. Thereafter a thorough description of the collection of data through the in-depth interviews will be given. The in-depth interviews include both the multiple case study interviews and the interview with TTK.

3.4.1 Industry Study

In order to better understand the Norwegian industry of Atlantic salmon farming, a thorough industry study was carried out. This was done by going through press releases, articles, firms websites, reports, and policy and mission statements related to the fish farming industry. Moreover, an unstructured interview with senior consultant in Rambøll, Geir Tevasvold was conducted to get an overview of the main challenges the industry face today, and how the firms in the industry are trying to cope with these. This has contributed to give a better understanding of the industry in general in addition to characteristics, development and outlooks. Also, it has contributed to an understanding of the competitive environment and challenges in the market of the case firms. The industry study will, together with the multiple-case study form the empirical background for this thesis.

3.4.2 In-depth Interviews

To be able to answer the proposed research questions, it was of crucial importance to obtain a thorough understanding of the case firms and their environment. After the case firms were selected, a second analysis of the documentary data was conducted to provide greater insight to the firm and its values and strategy, in addition to get an overview of the firm's network and competitive environment.

Lerøy Seafood Group (LSG) have annual reports available on their website, but Lerøy Midt do not have an individual site or report. Hence the information from LSG was used to give an overview of the firm's background. The researcher was not able to get hold of the annual report of Måsøval. However, the researcher had information about Måsøvals innovation activities through Rambøll. These sources made it easy to get information about the firms prior to the case selection.

Firstly, a general interview guide² was developed in line with the research questions and theoretical background. The background search of the interviewees indicated slightly changes to customize each interview guide to the respective cases. In Måsøval, the CEO has an economic background from NHH, and has worked in companies outside the farming industry which made it easy to use academic terms, though it was of importance that the interview would not be only focusing on the economic perspective concerning the research questions. Hence, the interview guide for Måsøval was adapted to serve this purpose. On the other hand, Lerøy Midt was represented by the production manager who has worked in the farming industry his whole career. The guide in this case needed to be adapted to his preferences and terms. The reason for this was to limit the distance between the interviewer and the interviewee, with the intention to stimulate for a good dialogue and rich, detailed answers. The interview with TTK was perceived after the multiple case interviews. The interview with TTK was less structured, as the aim was to create a dialogue to get a better view of how the aquaculture firms in the region operate³.

In qualitative interviews there is an emphasis on the interviewees' own perspectives and points of view. Departing from the guide is encouraged to get the interviewees view on what is relevant and important for the theme discussed ((Bryman, 2016). Further, the

²The interview guide can be found in Appendix G

³The interview guide can be found in Appendix F

interviews are intended to be flexible and open-ended, allowing change of direction depending on how the interviewees reply. Hence, it is important to be aware of that the interview guide is a guidance for the interview, and that it is expected that it might not be followed exactly the way intended. Though, the guide was developed to ensure that the main topics will be discussed in depth. The interview guides were structured as follows, containing 9 main elements:

1. Introduction.
2. Status today in the salmon farming industry.
3. Innovation activities.
4. The role of sustainability.
5. Post-smolt.
6. Regulations.
7. Challenges and risks.
8. Knowledge sharing and cooperation.
9. Future outlooks.

Additionally, the interviewees were given a short description of the structure of the interview and the main subject of the thesis at the beginning of the interview. This was done to ensure a common understanding of the topic to be discussed. Though, the information was limited so that the interviewees would not be affected by any thoughts or opinions. Each interview was planned to be executed in one hour. Both case interviews were done face to face by using Skype. This was due to the time limit of the research, in addition to the location of the case firms. Also, Skype was used to limit the threshold for the managers to be interviewed as Skype is more flexible than a face-to-face interview. The possible limitations of using Skype will be discussed later in this section. Both interviews were recorded with audio-recording equipment, with the consent of the interviewees. The recording was done in order to avoid bad recall of what had been said, and for the interviewer to be responsive and focused on what was said rather than focusing on taking notes. Though, a few notes were taken during the interview to easier keep track of important statements. Additionally, taking notes made it more natural to look down on the interview guide during the conversation, giving the dialogue a good flow. Also, taking notes contributed to natural pauses in the interview which gave room for the interviewee to reflect and amplify their answers, encouraging the interviewee to elaborate. Moreover, by recording the interviews, it was possible to go through them again and transcribe. This allowed for thorough examination of the answers, and helped control the analysis being influenced by the interviewers values or biases. The interview with TTK was also performed using Skype. Though, this interview was performed after the case interviews with Måsøval and Lerøy Midt. Thus, it enabled to reflect around the data collected through the case interviews, and discuss this with TTK. To be able to have a discussion, the interview with TTK was more unstructured than the case interviews. This interview was not recorded. Using Skype as

a tool is not without limitations, however. Since Skype is a platform that is dependent on Internet connection, there is a potential for technological problems. This can result in fluctuations in the quality of connection, and, thus, bad flow of the interview and poor recordings. Bryman (2016) argues that interviewees are more likely to fail to be present during a Skype interview than face-to-face interviews. By being good prepared for the interviews by preparing an interview guide suited for each firm and ensuring good Internet connection, these drawbacks were avoided.

3.5 Data Analysis

Analyzing the data gathered is often seen as the most difficult part when performing a case study as there is no specific recipe on how it should be done. At this point it is important to reduce the complexity of the data. Despite that the purpose of qualitative methods is get diverse perspectives, varieties and viewpoints, a structure of the data is important to develop an understanding (Jacobsen, 2016). By assembling the data gathered, patterns, regularities, deviation or underlying causes can be identified. Thus the process of analyzing qualitative data is a continuous exchange between the trivia and the entirety. This method of analysis is called hermeneutics method (Jacobsen, 2016).

The analysis of the data has been carried out in four steps. The first was to transcribe the interviews. Next, the transcribed interviews were examined unsystematic to see if any topics stood out. At this step, a word cloud for each of the case interviews was created.⁴ This helped the researcher in finding important themes. The third step was to categories the data. The phenomenons found by analyzing the in-depth interviews were also analyzed in the industry context. This was done by comparing the findings from interviews with characteristics from the industry as a whole. Further, these results were assembled with the findings in the interview with TTK. This was done to assure the validity of the analysis. According to Yin (2017), triangulation of data sources increases the validity of the research. From these data sources several characteristics were found to be repeating. These common characteristics, together with the theoretical perspectives formed the categories used for structuring the data from the in-depth case interviews. The categories are as follows:

- Introduction and Background Information
- Decision-Making Process and Strategy Development
- Sustainability
- Innovation
- Challenges
- Risk and Uncertainty
- Partners and Cooperation

⁴These can be found in Appendix A and B.

The last and fourth step of the analysis was to draw connecting lines between the different categories, and relate these to a more executive theme that is related to the research questions (Jacobsen, 2016).

3.6 Quality of Study

In this section, the quality of the research will be evaluated. Three tests are used as frameworks in order to evaluate the quality of this study: construct validity, external validity, and reliability (Yin, 2017).

3.6.1 Validity

Validity examines to what extent the data collected is relevant to the research questions (Yin, 2017). It is divided into two components: Construct validity and external validity. These two components will be discussed separately in sub-sections.

Construct Validity

“Construct validity refers to the extent to which a study investigates what it claims to investigate” (Gibbert et al., 2008, p. 1466). By using multiple methods of gathering data and referencing several sources of evidence, researchers can ensure construct validity (Yin, 2017). In this study, a variety of sources has been used to minimize the subjectivity in the evidence. This has enabled the use of triangulation to find similarities in sources of evidence, which gives the study strength, as well as discover conflicting information, which may help the researcher avoid misleading conclusions. It is believed that the use of industry experience, publicly available data and literature strengthens the study’s construct validity.

External Validity

External validity refers to knowing whether the findings of a study can be generalized to other situations beyond the scope of the study (Yin, 2017). The industry and case firms in this study were chosen based on the criteria presented in section 3.2 and section 3.3. Hence, it might not be generalized to all firms or industries. Though, as this thesis do not aim to answer a generalized conclusion, but rather provide insight and suggestions for further research. Replication was used in order to increase the external validity. As mentioned in section 3.3, the two case firms were chosen based on their similarities. However, the firms are different regarding size and internal resources. These are factors that are discussed in chapter 2 having an influence on a firms ability to implement green innovations and create a competitive advantage. The effect of this is discussed further in limitations in section 3.7. The study effort to identify processes and factors that are related to firms and industries ensures that the findings can be generalized. The research questions of this study are of the form “how” and “in what way” which makes it easier to generalize the findings (Yin, 2017). Thus, the external validity of the study is improved. Taking into consideration the study’s measures to improve the external validity of the study, as well as ability to perform generalizations, the external validity of the study is considered satisfactory.

3.6.2 Reliability

Reliability refers to the “consistency and repeatability of the research procedures in a case study” (Yin, 2017, p. 240). The goal is to minimize errors and biases. Lack of documentation is seen as one of the greatest weaknesses when performing a case study (Yin, 2017). The data collection methods of this study have been described thoroughly in section 3.4. All documentary data was collected prior to the interviews. This enables researchers to repeat the procedures conducted in this study. Thus, the thorough documentation of the case study methodology significantly improves the reliability of the study. Additionally, the thorough description of the method of this thesis, and the assumptions and choices that are undertaken for this study, increases the reliability of the thesis (Yin, 2017). It can be mentioned that the researcher of this study has experience from the Norwegian aquaculture industry by working as a røkter⁵. This has contributed to increasing the reliability of the study as the researcher has hands-on experience from the industry.

3.7 Methodological Limitations

The qualitative method is not without limitations, and these need to be considered. These are limitations related to the research method, the data collection, as well as the data analysis process.

3.7.1 Limitations Regarding Research Method

Considering the study being qualitative and exploratory in nature its results and findings may not be easy to replicate. This is because findings may vary due the choice of semi-structured interviews. Moreover, the interviewee may withhold some information due to confidentiality, hence lead to misunderstandings regarding innovative projects.

Despite the advantages of using a case study, it also has its drawbacks. The case study design is criticized for not being rigorous enough. Throughout the study, several measures have been put in place to increase the validity and reliability of the study, e.g. selection of industry and case, a broad collection of data, and interview guides customized for each case firm, making it more rigorous.

Dyer and Wilkins (1991) argue that multiple-case studies tend to mean that the researcher pays less attention to the specific context and more to the ways in which the cases can be contrasted. Thus, the bias of the researcher might have influenced the interpretation of some data.

By using an abductive approach it is important that the case study interviews contains enough material related to the aspects of the themes that are relevant for the theoretical approach. If the theoretical perspectives are not discussed before the analysis of data, the interviews might miss information that is relevant to prepare specific interpretations based on theory (Kvale and Brinkmann, 2017). Though, the industry study and the unstructured interview with Geir Trevasvold in Rambøll were important sources prior to the case interviews in order to develop an interview guide that would shed light on the crucial themes to discuss the research questions.

⁵Røkter is a Norwegian term used for the people working in the daily production on the farms at sea

Further, because a case study is seen as a resource-consuming process, the time-frame of this study might be scarce in order to do a thorough analysis, especially with only one researcher. There might exist valuable information that is overlooked because it can only be observed by following the selected case firms over an extended time period.

Moreover, it is argued that quantitative methods result in stronger findings when it comes to generalization (Yin, 2017). A combination of qualitative and quantitative methods is recommended to get the most robust findings (Yin, 2017). Though, as argued by Rotvold and Suhr (2016) the newness of the topic studied indicates that there is a need for more qualitative research to better understand the concept of green innovation.

As mentioned, there are also limitations regarding the use of Skype interviews. However, interviewing through Skype enabled for flexibility regarding the time at which the interviews were to be conducted. Moreover, it is believed that Skype lowered the barrier for the case firms to contribute to the study.

Limitations Regarding Data Collection

Knowledge about the respective firms was limited to what could be retrieved from conventional channels. Thus, the data collection might have limitations due to data being withheld. Additionally, the large amount of data can make it hard for the researcher to sort out what is actually relevant. Hence, it can be argued that the collection of documented data may not be complete.

Since the in-depth interviews form the empirical basis for the study, the main challenge is how interpretation influence the empirical material, both in interpretation from the interviewee and interviewer. Moreover, the interview questions were chosen and posed in such a manner that the interviewees did not feel like defending themselves, but rather encouraged them to answer honestly.

Moreover, prior to the interviews, no relations were established to the interviewees. Therefore, the research approach was unbiased. However, as the interview guide was developed in accordance with the initial literature review and introduced theory as well as the industry study, it might have distracted the researcher from recognizing valuable findings beyond the scope of the preliminary data.

Representatives of a firm may have its own understanding of the firm and the industry context, hence the empirical data can be biased by subjective meanings of a single employee that not necessarily is in accordance to the case firm as a whole. To avoid the researcher get the wrong impression, a thorough firm background analysis and industry analysis was conducted. Moreover, the interview can be affected by reflexivity (Yin, 2017), which means that the interviewee gives the answer she or he thinks the interviewer wants to hear. To minimize this effect it is important to pose questions in such a manner that the interviewee does not take a defensive position.

Limitations Regarding Data Analysis

When gathering and analyzing the empirical data it was focused on interpreting each interview without personal bias to ensure the credibility of the resulting findings. Though, it is difficult to be one hundred percent objective when performing a data analysis. As the data analysis was done manually by the researcher, the findings may be affected by personal

perceptions and opinions. However, the researcher has taken precautions to not act biased. The discussion with TTK was intended to give new inputs and help draw the lines of the empirical findings. As there was only one researcher of this study, it is believed that the discussion about the industry with consultants in Rambøll, and the discussion with TTK have been important to help the researcher in having a broad view when analyzing the data. Still, there might exist categories and relationships that have not been discovered. Lastly, by using an abductive approach, it has been possible to reconsider and redevelop concepts and theories several times.

Chapter 4

Empirical Findings

In this chapter the empirical findings of the thesis will be presented. The first section includes an analysis of the Norwegian aquaculture industry. Thereafter, the in-depth interviews from the multiple case studies are presented. The last section of this chapter includes the interview with TTK¹. Analysis and discussions of the findings can be found in Chapter 5.

4.1 Industry Analysis

In Norway, environmental issues have been of central importance throughout the development of the aquaculture industry (Asche et al., 1999). In 2014, the Norwegian Ministry of Trade, Industry, and Fisheries presented in Report No. 16 to the Norwegian parliament that environmental concern should be the only evaluation for growth in the aquaculture industry (Regjeringen, 2014). The demand for seafood is expected to rise over the next decades due to increased global population, growing purchasing power and because more people are entering the middle-class (Marine Harvest, 2017). The Norwegian aquaculture industry is today in a situation where the markets worldwide scream for more salmon, but the restrictions due to sustainability limit the possibility for growth. The salmon lice problem is one of the main challenges. Seafood Norway 2017b state that a transparent and predictable growth will be crucial to overcoming these challenges. They further say (p. 23):

”The Norwegian aquaculture industry operates in a natural environment, which imposes a wide range of responsibilities on everyone involved. The authorities, the research community, and the industry have to work closely together to ensure that operations and production within Norwegian aquaculture facilities are sustainable and that a strain is not put on the essential resource that is the sea.”

The Norwegian aquaculture industry is the world leader in production and export of farmed Atlantic salmon, which has become one of Norway’s largest industries. Seafood Norway

¹Trøndersk Kystkompetanse

has a vision that Norwegian aquaculture shall be the world's most environmentally friendly production of food. And, that through sustainable production and innovation, the industry will be Norway's most important contribution to meet the UN Sustainable Development Goals (Seafood Norway, 2017a).

The Norwegian Seafood Federation's sustainability goals are based on the UN's Global Goals, where the first four are regarding environmental sustainability and the rest are concerning social and economic sustainability: (Seafood Norway, 2017a):

- Ensure sustainable consumption and production patterns (Goal 12).
- Take urgent action to combat climate change and its impacts (Goal 13).
- Conserve and sustainably use the oceans, seas and marine resources (Goal 14).
- Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss (Goal 15).
- End hunger, achieve food security and improved nutrition and promote sustainable agriculture (Goal 2).
- Ensure healthy lives and promote well-being for all at all ages (Goal 3).
- Promote inclusive and sustainable economic growth, employment and decent work for all (Goal 8).
- Build resilient infrastructure, promote sustainable industrialization and foster innovation (Goal 9).

In the following section, the development of Norwegian Atlantic salmon farming will be presented. The industry study will focus on characteristics of the industry, innovation activities and sustainability, as well as how regulations have formed the industry. This section will start with an introduction of the Atlantic salmon and the salmon production cycle to give a better understanding of the product. Next, the development of the Norwegian aquaculture industry will be presented, followed by the structure of the industry. Then, a brief overview of historical innovations is given with a special focus on the development of post-smolt. Thereafter, the regulations that are seen as relevant for this thesis are presented. Lastly, important risk factors are described. To narrow the scope of the thesis, the focus here will be on salmon lice and optimal rotation.

4.1.1 Atlantic Salmon

Atlantic salmon belongs to the Salmonidae family together with e.g., Pacific salmon, brown trout, and seawater trout. Species of the Salmonidae family are available from both wild and farmed sources, though Atlantic salmon that is commercially available originate mainly from captivity (Marine Harvest, 2017). This thesis will focus only on farming of Atlantic salmon.

Salmon Production Cycle

The wild Atlantic salmon develops in two phases. It spends its juvenile phase in rivers before migrating to sea for its second phase to grow and mature. Salmon farming imitates the natural stages for the salmon to develop. As salmon is a cold-blooded animal, temperature is important for its growth rate, and the optimal temperature rate for Atlantic salmon is 8-14 degrees (Marine Harvest, 2017). The traditional production cycle of farmed salmon takes approximately 3 years. In Norway, smolts are usually released into seawater twice a year. When salmon is harvested, the location is fallowed for 2-6 months before new smolts are released at the same location.

Ova The salmon roe or eggs are developed in incubators containing freshwater, approximately 5000 eggs per liter. It takes around 60 days for the eggs to hatch with a temperature around 8 degrees (Seafood Norway, 2017b).

Alevins The just-hatched fish are called "alevins" and still have the yolk sac attached to their bodies. 4-6 weeks after hatchery, the alevins have absorbed their yolk sac and become increasingly more active. In this phase, they are moved to a bigger container and the farmer starts the feeding (Marine Institute Foras na Mara, n.a.).

Parr The parr is characterized by its dark spots along the sides of its body. At this stage, the fish is extremely sensitive to changes in water quality, habitat and climate. The spots are intended for camouflage. At the end of this phase, they undergo a physiological pre-adaptation to life in seawater by smolting, i.e. internal changes in the salt-regulating mechanisms of the fish. This is easily seen by changes in their appearance as they become silvery and swim with the current instead of against it. The process of smolting is done by regulating artificial light. In the beginning, the fish is exposed to a small amount of light which increases for each day. The use of light tricks the fish into believing it is spring and therefore it prepares for its journey to the ocean (Marine Harvest, 2017).

Smolt After 10-16 months in freshwater the fish is ready for life at sea. The smolt is transferred to sea by boat. During transportation, the smolt is exposed gradually to water with higher salinity to prepare it for the salinity of seawater (Marine Harvest, 2017).

Adult Salmon At this stage the salmon are kept in pens in the sea for 14-22 months. How long depends on the preferable weight of the salmon. Normally this is around 4-6 kilograms. When the salmon reaches its preferred weight it is transported by boat to the slaughterhouse. Here it is sedated, euthanized, washed and sorted by size and quality before it is laid on ice and distributed to customers all over the world (Seafood Norway, 2017b).

4.1.2 Industry Development

Two brothers, Karstein and Olav Vik from Sykkylven, were the first to explore the possibilities for farmed salmon in Norway. In 1955, they excavated three ponds; one for saltwater, one for freshwater and one for brackish water with the purpose of proving that

salmon is capable to breed and feed in captivity, which they managed. Later, they developed floating baskets with dimensions 5x5 meters and later 10x10 meters. These were the forerunners of today's well-known pens (Berge, 2014a). The first commercial farm was established outside of Hitra during the 1970's by two other brothers. Ove and Sivert Grøntvedt are by many looked upon as the pioneers of Norwegian farming of Atlantic salmon. The Grøntvedt brothers developed a floating pen shaped like an octagon. This was named "Grøntvedt-merden". They experienced rapid growth and were considered very successful, which inspired others to farm salmon (Berge, 2014b). Additionally, there was an increasing interest among researchers on fish farming, which resulted in a positive cooperation between researchers and farmers (Olafsen et al., 2002). Hence, during the 1980s the whole industry experienced high growth. The Norwegian government early established two stations dedicated to aquaculture research, Matre (Institute of Marine Research) and Sunndalsøra (Norwegian University of Life Science), with a research focus on selective breeding, nutrition, general production techniques, and delivery of smolts to commercial farms. At the beginning of the Norwegian aquaculture industry, during the 1960s and early 1970s, no license was required to operate a salmon farm. But, in 1973, it was established a requirement for only one license per firm (PwC, 2017). This restriction encouraged Norwegian firms to invest in salmon farming in other countries (Asche et al., 2003). Hence, a transfer of technology and knowledge across borders took place. Thus, in 1981, the permanent Aquaculture Act was implemented which opened up for new licensing. This was revised in 1985, where the objectives were focused on profitability and regional development (PwC, 2017). This way, they managed to distribute the industry along the entire Norwegian coastline. This led to a rapid growth in production, but with the growth came problems such as diseases. The industry collapsed, and the restrictions were removed, which opened up for consolidations (Torrissen et al., 2011). During the 1990s the industry was regulated based on feed quotas (PwC, 2017). In 1991, the Norwegian aquaculture industry was mainly owner-operated with a total of 823 licenses, and the ten largest firms controlled only 8% of the industry. In 2002, the price for salmon dropped below 20 NOK per kg, which resulted in more consolidations and a new round of issuing licenses. In 2004 the feed quotas were replaced with today's MAB-restrictions (explained in section 4.1.5). Licences were later issued in 2009 and 2013. By 2012, the number of firms in the industry was reduced to 171 (Asche et al., 2013). 2013 is considered the last year where licenses were sold to farmers. Since then, licenses have been assigned based on development and sustainability. The development in the industry has been characterized by a learning-by-doing culture, whereas failure or success has decided the path. When a fish farmer experienced success with a new process or product, other actors in the industry would copy the solution. Norwegian fish farming has a history of not being very competitive. Rather, the industry has been open with few barriers regarding market and sales. Hence, frequent communication and imitation outlined the industry. In other words, the development in the industry is not based on R&D, but through practical experience. Much of the development in the industry has been made possible due to collectivistic attitudes and exchange of knowledge, services and material goods. These characteristics have been associated with the culture of coastal regions and fishermen.

4.1.3 Industry Structure

Today, the industry is heterogeneous when it comes to firm size, with a mix of family-owned and multinationals. There are a total of 151 companies who own commercial licenses for salmon and trout in Norway, however, some of these are controlled by other companies. The total supply is produced by 98 companies (through themselves or subsidiaries), whereas the ten largest firms control 70% of the industry (Marine Harvest, 2017).

	Top 10 - Norway	H.Q.
1	Marine Harvest	236 000
2	Lerøy Seafood	115 700
3	Salmar	115 600
4	Mitsubishi	60 000
5	Grieg Seafood	40 500
6	Nova Sea	37 100
7	Nordlaks	35 000
8	Sinkaberg-Hansen	29 000
9	Norway Royal Salmon	26 800
10	Alsaker Fjordbruk	26 500
	Top 10	722 200
	Total	1 054 000
	Share of Total	69%

Table 4.1: Top 10 Norwegian farmers

The report by Olafsen et al. (2002) divide the structures of the firms in the industry in three categories. These are described below.

Independent operator These firms often have 1-2 licenses to operate. Usually, they do not have established arrangements with suppliers, slaughter, export or others. Instead, they buy service from these actors when needed and based on good offers. Though, they cooperate with suppliers of feed, which is their most important partner. Slaughterers are also of importance, though the firm can switch among 2-3 actors. The firm sells products to exporters and operates in the spot market. The firm might participate in a few research projects conducted by suppliers or research institutions.

Horizontally integrated These firms operate with 3-9 licenses and have included a greater part of the value chain in-house. These firms are often part of a sales organization that organize marketing and sales. Often, these firms have done a couple of acquisitions, but are still managed by the family who founded the firm.

Vertically integrated This is a firm with 10 or more license to operate. This type of firm manages the whole value chain from roe to processing. The processes in the value chain are organized in different subdivisions whereas the firm owns 100% of the shares. These subdivisions may be independent operators which have been acquired by the firm.

The independent operators are often family-owned with traditions in operation and know-how established through generations. Additionally, they have a short distance between the employees and the decision makers. Also, knowledge-sharing between the practitioners and the theoreticians flows easily. Though the independent operators oftentimes do not have the resources to perform internal R&D, they are dependent upon external knowledge pools. The vertically integrated operators are larger groups where the owners usually have experience from fisheries or other coastal professions. In vertically integrated operators, innovative activities take place through learning by doing, which yields results that are spread in the industry by other firms which are copying the solutions. Many of the innovations in the aquaculture industry development were done by trial and error, and this is still a method used today. Still, these larger groups often cooperate with external knowledge sources to solve problems in production, or to come up with new solutions. However, it has been observed that due to high production costs, the larger groups often focus on short-term innovations rather than investing in long-term developments (Olafsen et al., 2002). The Norwegian suppliers to aquaculture industry are known as the most diversified and innovative in the world (Asche, 2008). In Norway, the suppliers are crucial for the aquaculture industry. Roe, feed, technical equipment, and services are usually delivered by suppliers. Moreover, suppliers are the main source of innovation in the industry. This is mainly because they are interacting with many of the actors in the industry and thereby receive knowledge from different areas (Regjerings, 2014). Thus, the expertise to combine these innovations is still performed by the farmers operating on the principles of trial and error. Hence, the communication between farmers and research often goes through suppliers (Olafsen et al., 2002). This way of innovation can create problems such as unexpected events that can appear in the production, which generates costs. The other problem is that farmers may have difficulties in demanding solutions from the suppliers due to a lack of systematic knowledge because development is done based on trial and error. Hence, the innovation rate in the industry lowers. From the start in 1970 until today, the Norwegian fish farming industry has had a tremendous growth in production. This is primarily due to innovations that have increased control over the production process (Asche, 2008). Historically has the farming of Atlantic salmon in Norway been profitable. Over time the cost of production has decreased from 30 NOK per kilogram to 17 NOK per kilogram (Marine Harvest, 2017). Though, since the end of the 1990s the production costs have stabilized, and actually increased. It is proposed that this is due to regulations regarding location, the volume of biomass, feed, and vaccination. The industry has also struggled with challenges such as salmon lice, escapes, diseases, waste from production and market uncertainty. The last couple of years, demand for Atlantic salmon has been significantly higher than production which has been profitable for the industry. However, up until 2013, growth in production of Atlantic salmon has been strong, with a yearly growth rate of 10% (Norsk Industri, 2016), the years after until today, the industry has experienced a recession in production. The main reason for this is the salmon lice and its repercussions (Norsk Industri, 2016). Though, the overall value creation has doubled since 2012 to 2016 due to high export price on Atlantic salmon (Norsk Industri, 2016).

4.1.4 Innovations

Today, the industry is still driven by the principles developed by the Grøntvedt-brothers. Though, as the salmon farmers gained control over parts of the production process, innovation processes and systematic gathering of knowledge could be started (Asche, 2008). Innovation concerning breeding was of special interest during the early stages of Norwegian fish farming. Researchers managed to use knowledge from the breeding of cows and pigs and use this expertise in developing salmon with a high growth rate and late maturity. Closing the production cycle by producing juveniles from a breeding stock kept in captivity gave control of the biological production process which enabled systematic research and knowledge gathering (Asche, 2008). This opened up for specialization, as control allows one to handle fewer issues at a time. Hence, some researchers could focus on feed, some on disease control, and others on technology. The evolution of the Norwegian salmon has been unique, and, today, it is seen as outstanding in an international context. Fish feed is an area of research where Norway has managed to create a competitive advantage. The development in fish feed has been a priority for fish farmers since the beginning. Regulations in 1996 set a limit for maximal feed used by each location, which increased the farmers' incentives to innovate for new solutions. As a result, they managed to optimize composition in fish feed and the industry is now on a feed conversion ratio of 1,1² (Marine Harvest, 2017). As of today, salmon in Norwegian farms need significantly less feed than wild salmon to reach the same weight (Thodesen et al., 1999). The development in technology and location has also changed over time. In the beginning, the pens were handmade out of wood and localized close to the shore in shallow waters. The size has increased with time, and the location is moved further out on deeper waters. Today, a normal pen is between 20 and 50 meters deep, with a diameter of around 50 meters. The number of fish contained in one net pen is strictly limited to 200,000 in order to give the fish enough open space. Each open net pen contains approximately 2,5% fish and 97,5% water (Seafood Norway, 2017a). Further, innovations regarding fish disease have decreased production costs. During the 1980s the industry faced challenges with diseases. The use of medication and antibiotics rose, but, due to innovations among researchers, the use diminished during the beginning of the 1990s. There has also been a development in the land-based production. The water recirculation technology called Recirculating Aquaculture System (RAS)³, which reduces the demand for water dramatically, is increasingly replacing the traditional flow-through (FT) systems⁴. As the production of juveniles requires a supply of large quantities of fresh water, the development in RAS-technology has been of great importance. The RAS-technology opens up for farmers to have a higher degree of control of critical growth factors. This has enabled increased production volume and to breed the smolt longer before transferring to open net pens. The report by Norsk Norsk Industri (2016) state that up until now, the Norwegian aquaculture has been a technology market leader, and that this has been done through modifications of existing solutions. Hence, the report by Norsk Norsk Industri (2016) urge the need for more investments in R&D and a higher focus on cooperation among actors in the industry. The future of the Norwegian aquaculture will depend on the ability to find new ways to cultivate the

²Feed conversion ratio tells us the kilograms of feed needed to increase the animal's body weight by one kg

³RAS is illustrated in Appendix C

⁴FT system is illustrated in Appendix D

sea sustainably. Technology breakthroughs such as Blockchain, IoT, Robotics, Drones, Big Data and AI will probably shape the industry in the next years. This can enable cost reduction and increase automation and efficiency in production (PwC, 2017). The report by Marine Harvest (2017) identifies a correlation between technical change in the industry and cost reduction. Their results indicate that the industry has had an average rate of technical progress of 4.1% over the period 1988-2010. Though, the recent years, this rate has slowed down. Marine Harvest (2017) found that from 2006-2010 the technical progress has been below 1%. They argue that this indicates that the industry is not able to innovate at a rate that yields lower production costs. Asche et al. (2009) investigated the technical⁵ and allocative inefficiency⁶ in salmon farming. Their findings imply that the Norwegian salmon farming industry is allocative efficient. However, they suggest that there is still room for improvement regarding technical efficiency. By improving technical efficiency, both cost and the environmental impact could be reduced.

Post-smolt

Today, farmers are looking at possibilities in offshore farming, in addition to new technology for farming in closed, semi-closed and open systems. One particular field of interest in the aquaculture is the development of post-smolt. The maximum individual weight of the smolts in the hatcheries has earlier been restricted to maximum 250 grams, but the ministry has recently been given the right to extend the juvenile phase in closed land-based systems until the fish reaches a size of up to 1000 grams (Fiskeridirektoratet, 2015a). The technological development from Flow-Through (FT) to Recirculating Aquaculture Systems (RAS) has enabled for more control of production and made it possible to produce larger smolts on land. This new system of production gives possibilities for the farmers to optimize the use of the licence to operate. When reducing time in the sea, there is a potential for reduction in the outbreak of lice. Furthermore, it gives possibilities for a production method where larger and more robust smolts (post-smolts) are transferred to sea cages. Post-smolt makes it possible for the farmer to release the fish in open net pens at times of the year that has been too rough for smaller smolts. Thus, it opens up for possibilities to take better advantage of the MAB as post-smolts can reduce the time at sea by 6-7 months (Nofima, n.d.). However, implementing the new system of production involves high costs. For the project to be profitable, these investments must pay off during the time at sea. The hypothesis is that these costs will balance out due to increase in growth, decrease in mortality, and optimal exploitation of localities and biomass (Fiskeridirektoratet, 2015a).

The development with post-smolt is at an early stage, and there is little available information on research done. Though, only good results are presented so far

4.1.5 Regulations

The Norwegian government has an extensive impact on the aquaculture industry. The government's goal is that Norway becomes the world leading seafood nation, with 5 million tonnes of sustainable production by 2050 (Olafsen et al., 2012). Every salmon farmer

⁵Technically inefficient firms use more inputs than necessary to produce a given quantity of output

⁶Explained by Asche et al., (2009) as a suboptimal input factor mix given the prices of inputs and technology in place

needs an official license to operate. To get a license granted, the authorities demand environmental surveys that provide information about the site and ocean floor conditions. When a production cycle is complete, the site must be left empty for at least two months before it can be used again. All the fish in one pen needs to be at the same age. If the requirements from the authorities are not met, the site can be stopped. Thus, all installations in the area must be removed within six months (Seafood Norway, 2017a).

Aquaculture Act

In Norway, the aquaculture industry is highly regulated whereas The Aquaculture Act (2005) is one of the most important amendments. “The purpose of this Act is to promote the profitability and competitiveness of the aquaculture industry within the framework of a sustainable development and contribute to the creation of value on the coast” (Lovdata, 2005). The law states that you need a license to operate in the aquaculture industry. Licenses for operating in fresh water, e.g. production of smolt, are not limited and can be applied for at all times, whereas the number of licenses to operate in seawater was, in 2016, limited to 990 (Marine Harvest, 2017). These are allocated by the Norwegian Ministry of Trade, Industry, and Fisheries and are administered by the Directorate of Fisheries.

The license, in addition to specifying where one can operate, also provides a measure that limits production by defining the maximum volume of fish allowed in the sea at all times (Asche et al., 2013). This measure is called Maximum Allowable Biomass (MAB). A normal license allows for 780 tonnes standing live salmon except for the two northernmost counties, Troms and Finnmark, where it is 945 tonnes (Lovdata, 2005). Today, these licenses can be merged together at a single plant or farm, where the operator is allowed to have 1-6 licenses. The sum of the MAB permitted by all the licenses held in each region is the firms total allowed biomass in this region. In addition, each production site has its own MAB and the total amount of fish at each site must be less than this set limit. Generally, sites have a MAB of between 2.340 and 4.680 tons (Marine Harvest, 2017). In addition, the Aquaculture Act provides instructions on how to operate concerning environmental monitoring, control, requirements for equipment, waste and escaped salmon (Lovdata, 2005).

Development Licences

Development license is assigned projects involving radical innovations and high investment costs (Fiskeridirektoratet, 2015b). Additionally, these projects often include high risks. The goal is to motivate for development of new technology that can solve environmental challenges and challenges concerning the location of salmon farms, e.g. prototypes of constructions and facilities, installation of new equipment and full-scale trial production (Fiskeridirektoratet, 2015b). It is also required by the government that results from these developments will be shared with the other actors in the industry.

Green Licences

The Norwegian Ministry of Trade, Industry, and Fisheries authorized, in 2015, 45 Green licenses with the objective to stimulate innovations of new technological solutions to re-

duce environmental impacts with escapes and spread of salmon lice. Additionally, the aim is to facilitate sustainable aquaculture with a competitive advantage that can contribute to value creation for the industry and nation (Fiskeridirektoratet, 2016).

Traffic Light System

In January 2017, a new regulation with the intention to ensure sustainable growth was announced. This new regulation is named the traffic light system. In the new system, the coast is divided into 13 areas of production as showed in 4.1, and possible future growth is based on the level of sea lice in each area. The color of the traffic lights indicates the environmental status of the area. A green light indicates a permission for growth, yellow means no change in production, and a red light indicates a reduction in biomass. If the criteria in an area are met, i.e., green light, the production may grow by a maximum of 6% every two years (PwC, 2017). Though, farmers are also offered growth if they can document zero lice or below 0.1 adult female lice per fish at all weekly counts with maximum one treatment. This means that closed systems are possible in areas with yellow or red light (PwC, 2017).

4.1.6 Risk Factors

Farming of Atlantic salmon involves risks in production. Factors that influence the production output can be split between controllable and non-controllable (Oglend and Tveteras, 2009). The controllable inputs include smolt release into pens, labor, feed, capital, and materials. Decisions concerning vaccination and treatment of diseases can also be seen as controllable variables. Non-controllable variables are disease outbreaks, sea lice, fingerlings, algae, temperature changes and extreme weather conditions (Oglend and Tveteras, 2009). Aquaculture is vulnerable to the environment, and the non-controllable variables can create exogenous shocks. In return, these shocks might have negative economic consequences for firms. For the Aquaculture, a biological shock can result in unstable production and supply, in addition to issues with the replacement of lost products. Together, these inputs determine production levels and the quality of the fish. In salmon farming, the non-controllable inputs are dependent on the localization of the farm. Oglend and Tveteras (2009) propose that geographical diversification of production units can significantly reduce fluctuations in returns and reduce sensitivity to local risk factors. This thesis will focus on the controllable variable optimal rotation, which is explained further in the next section, and the non-controllable variable salmon lice.

Optimal Rotation

Guttormsen (2008) discusses the optimal rotation in Aquaculture. By rotation, he refers to when and how many fish should be released into the pens, and allocation of controllable inputs. As described in section 4.1.1 the process of fish farming in the sea is that the farmer release a certain number of juveniles into the pens, feeds them, and harvest the fish when they have reached the desired weight. After the salmon has been harvested, the pens become available for a new generation of juveniles. The farmer can choose between short cycles with smaller fish or produce larger fish with longer time in the pens. Hence,

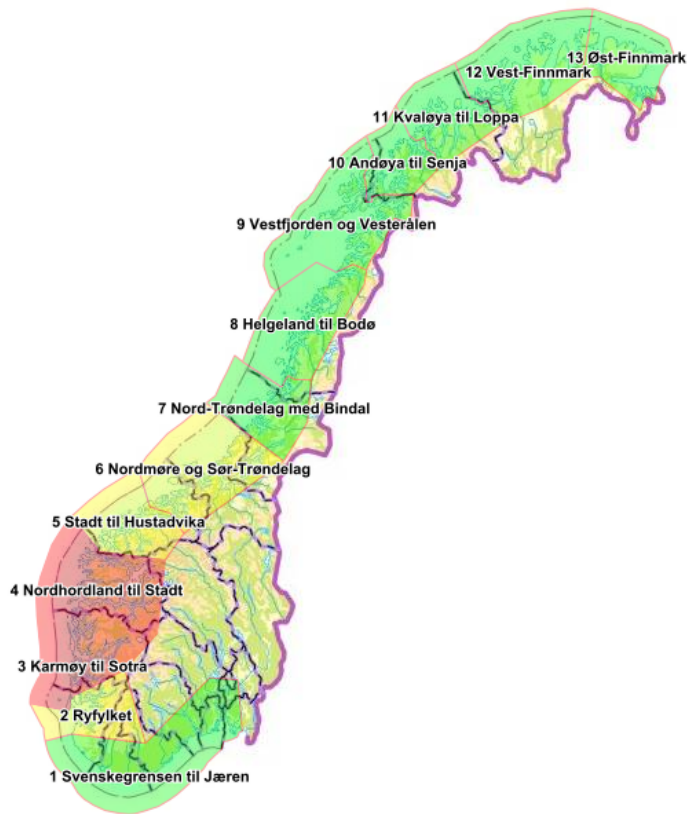


Figure 4.1: Production areas

when to transfer juveniles to the pen, and when to harvest the fish. Guttormsen (2008) underline the biological aspects concerning optimal rotation. He discusses the fact that salmon smolts only can be released during certain periods of the year. Guttormsen (2008) states that as the firms in the aquaculture industry become larger and the industry becomes more competitive, the timing of harvesting is a key factor for success. Under normal production, the highest mortality will be observed during the first 2 months after the smolt is put into the sea (Marine Harvest, 2017). Mortality later in the cycle is mainly due to diseases, lice or predators.

A report by The Norwegian Food Safety Authority (NFSA) (Mattilsynet, 2014) states that smolt of bad quality is one of the main reasons for mortality in Norwegian salmon farming. Today, smolts are released in pens either during spring (April) where it is harvested in fall (August-December) the year after, or smolts are released in fall (August) and spend 16-18 months in the sea. Smolts released during spring will go through one winter with low water temperatures and extreme weather conditions, and two summers with blooming of algae, disease outbreaks, and sea lice. If the farmer chooses to release the smolts during fall, the fish will go through two cold winters and one summer. Both

solutions can give exogenous shocks.

Salmon Lice

Today, the focus is first and foremost on developing solutions to hinder the spread of salmon lice and escapes of farmed fish, in addition to capturing spillover effects from feed (Marine Harvest, 2017). The salmon louse is a natural parasite that can be found in areas in the northern hemisphere. It feeds on fish by eating their mucus, skin, and blood. Hence, creating wounds on the salmon which can lead to infections and harm the salmon's ability to regulate salt. It has been documented that there is a relation between infestation of salmon lice and the effect on the fish physiology and mortality (Norsk Industri, 2016). As mentioned, the louse occurs naturally, but it multiplies when many hosts are available. And, with the expansion of the aquaculture, the conditions with salmon lice has become one of the major challenges for further growth. The louse breeds throughout the year, but it reproduces at a higher rate in the summer when the sea is warm. It thrives best in waters with temperatures more than 4 degrees. Moreover, it weakens as salinity declines. The Norwegian government has established strict regulations for the allowable amount of salmon lice in a facility. Today this is fewer than 0,5 adult female lice on average (Seafood Norway, 2017b). Failure to keeping the amount below the limit results in the whole facility being slaughtered.

The correlation between salmon farms and the blossoming of sea lice is noted by many scholars (Forseth et al. (2012); Stien et al. (2012); Taranger et al. (2014)). It is argued that sea lice have a density-dependent negative feedback mechanism and that this can result in a reduced growth in production of salmon (Stien et al., 2012). It is further argued that as salmon farms cultivate sea lice due to the high density of hosts, the louse can be seen as an externality produced by the industry (Stien et al., 2012).

There are also high costs related to salmon lice. These costs include direct loss of fish, expenses to treatments and loss of biomass due to stress, and is estimated to be approximately 500 billion NOK per year (Ramsden, 2016).

The aquaculture industry works closely together with government institutions and researchers to find solutions that reduce the salmon louse population. The industry monitor and document the existence of lice on a weekly basis. Today, the industry operates with three different ways of combating salmon lice: Through biological methods (e.g. cleaner fish), using a Thermolicer (patented mechanical method) or through treatment with authorized medication (baths or feed additives) (Seafood Norway, 2017b).

4.2 Multiple Case Study

This section presents empirical data gathered from the in-depth case interviews with Måsøval and Lerøy Midt. The data is presented for each firm individually, where the structure is based on the seven categories as presented in section 3.5. The first case firm to be presented is Måsøval and thereafter Lerøy Midt.

4.2.1 Måsøval

Introduction and Background Information

In 1973, Edvin Måsøval and his sons Karstein and Bjørn established Måsøval Fiskeoppdrett AS (Måsøval). In 1991, Karstein Måsøval became the owner of the firm. He has later been active in the establishment of Norway Royal Salmon, which is one of the largest firms in Norway. Today, Lars and Anders Måsøval, the sons of Karstein Måsøval, are the owners of the firm. During the last 15 years, the firm has experienced an increase in production due to sustainable growth, consolidations and accredited license to operate. In 2011, Måsøval acquired a salmon farming firm named Lernes in Hemne in addition to two hatcheries at Frøya and Hitra. Further, Måsøval has established a joint venture with Gunnar Espnes and owns 66% in Gunnar E. Fiskeoppdrett AS. Through the consolidation, they received four new licenses to operate. Today, the firm owns 9 licenses and operates in seven different localities (see figure X). Måsøval AS is one of three family-owned salmon farming firms in the region and has approximately 65 employees. Additionally, Måsøval has bought shares in an Icelandic salmon farming firm where Måsøval owns 53,5%.

Decision Making Process and Strategy Development

Måsøvals strategy has for long been growth, and the firm is known for having achieved organic growth throughout the years. In 2015 CEO Lars Måsøval was named EY Entrepreneur Of The Year in Midt Norge. To qualify for this price, firms have to fulfill the “3x20” requirements, which means that during the last two years the firm has to have a turnover of 20 million, 20 employees and 20 percent growth.

“As long as the prices per kilo on salmon continue at the level it is today, the strategy will be to produce as much as possible. I think that as long as we have regulations this strategy will hold for the whole industry.”

— CEO Asle Rønning

In the industry, the fixed costs stand for the majority of the expenses. With a high production level, these costs are reduced as they are divided by the quantity of production. As for now, the product, Salmon, is more or less the same. The Norwegian firms are not differentiating. So until the market becomes smarter, the competitive advantage is created in the production process. As mentioned in the industry study in section 4.1.3, it will be crucial for the farmers to lower the production costs in the future as these for long has been quite high.

Sustainability

CEO Asle Rønning considers Måsøval a sustainable firm. He argues that the salmon farming industry gets an unfairly bad reputation. As the industry does not receive any subsidies it creates value at a national level in form of taxes, fees, and competitive workplaces. Rønning underlines that this also is an important part of the sustainable development of the industry.

“Few people actually understand how sustainable the Norwegian salmon farming industry is. Take for example Norwegian agriculture: it takes approximately 800-900 farmers to produce 5 million kilo meat during a period of 18 months, whereas in salmon farming it takes only one farmer, us, to produce 5 million kilo meat in the same period of time.”

— *CEO Asle Rønning*

Because of the bad reputation of the industry, Måsøval wishes to contribute to communicating the strengths and the work that the industry does to achieve sustainable growth. Rønning underlines that they are aware of the challenges the industry is facing, especially concerning salmon lice, and that it is crucial for the industry to cope with these challenges for sustainable growth. New innovative solutions is a step in the right direction, and Måsøval aims to be an active contributor to sustainable development in the industry by taking lead in innovative projects.

“Måsøval wants to actively participate in the industry. We do it by being in front when it comes to sustainability, and dare to take a leading step in the right direction.”

— *CEO Asle Rønning*

One of the sustainability projects Måsøval participate in is the voluntary certification by GlobalG.A.P. This is a standard that guarantees good agricultural practice. Through certification, Måsøval wants to assure consumers and partners that their production complies with the standards of GlobalG.A.P. stating high product quality, food security, animal welfare, and environmental impact. For Måsøval this standard has helped strengthening the firm's market position, in addition to securing good routines internally both in production and administration. Additionally, one of the sites is certified by the Aquaculture Stewardship Council (ASC). ASC is an independent, international non-profit organization that manages the world's leading certification and labeling program for responsible aquaculture. The program aims to minimize the environmental and social impact of aquaculture.

Innovation

Often, new ideas derive from the suppliers in the industry. It is not hard for Måsøval to find an innovative project to participate in.

“We have a long list of innovative ideas from suppliers. The industry is full of people like Gyro Gearloose. It is rather that you have to limit yourself so that the projects you participate in are done properly.”

— *CEO Asle Rønning*

For these suppliers, it is important to find a farmer that is willing to test some of their prototypes. Måsøval has freely been participating in pilot projects based on ideas that arise from suppliers. CEO Asle Rønning state that the initiatives to new innovative solutions

derive from the whole industry. All actors are eager to participate in the development of new technology. The challenge is to formulate all these new ideas and put them into systems to be able to test them out. Among 15 new ideas, only one will probably function in real life. However, Rønning stresses the importance of the willingness to try out new ideas.

“In regard to firm size, I don’t think you will find any other actor in the industry that participate in as many innovative developing projects as Måsøval do”

— *CEO Asle Rønning*

Måsøval was the first in the industry to decide to implement land-based electricity to the farms on the sea. This initiative was to decrease the use of energy by 35-40%. This is a project that might now be profitable in the short-term, but rather a long-term investment. Later, other firms in the region followed Måsøvals lead. Additionally, Måsøval has developed Helixir, a sea fleet that is used to treatments regarding sea louse. With Helixir, Måsøval has managed to take down the use of medication by 90%. Rønning state that Helixir might not become a profitable investment for Måsøval, but he underlines that it reveals the firms will to take on green innovative projects. Today, Måsøval is looking at the possibility to produce post-smolt on land. This is a new way of production that will help the firm in utilizing the MAB-restrictions and prevent attack by salmon lice, and other non-controllable variables. CEO Asle Rønning sees huge potentials for growth in the region. Though, this requires better exploitation of the existing localities and licenses. Moreover, technologies and new concepts open up for the use of localities that have not been suitable earlier. As post-smolt can decrease the time spent exposed at sea, the environmental impact from the production will decrease. Thus, growth in production is possible. Additionally, the industry is quite young and dynamic, hence many solutions yet to be invented and industrialized.

Challenges

The last couple of years Måsøval has had tremendous challenges due to salmon lice and fish welfare. This has lowered the efficiency of production and given increased costs.

“I think that now, the main focus of the farmers in this region is to come up with new methods and innovative solutions to cope with the salmon lice so that both fish welfare and production will comply with our goals”

— *CEO Asle Rønning*

The most serious event took place autumn 2016. Måsøval experienced a huge loss in production due to salmon lice. The costs were estimated at 100 million NOK. This event was displayed in the media, and led to a bad reputation for the firm and the industry.

Risk and Uncertainty

Participating in innovative projects, such as post-smolt, generates risks. For Måsøval it is important to balance the resources used for new solutions, and the resources used for producing salmon.

“We must not forget that our aim is to produce high-quality salmon. A huge risk is that new projects disturb the daily production.”

— *CEO Asle Rønning*

Hence, it is important for the firm that the main focus always is on the production of salmon. To avoid high risks due to non-controllable variables and optimize MAB, Måsøval is, as mentioned, looking at opportunities to keep the smolts in closed contained conditions for a longer period. Though, Måsøval is aware of the high costs and risk that runs with this type of innovation. Hence, concerning the development of post-smolt, Måsøval have one strategy for the short-run and one for the long-run. The short-run strategy is to produce post-smolt in semi-closed conditions at shore, whereas the long-run strategy is to produce post-smolt on land. Senior Consultant in Rambøll Eskill Forås is involved in the long-term strategy. His task is to come up with a proposal on how Måsøval can develop land-based post-smolt. A project of that size will demand an investment of approximately 300-400 million NOK. Hence, it is important with a thorough evaluation of the potential of the project.

“In a best-case scenario, the plant will be up and running in 2021. Thus, it is a long-term investment. But for an industry like us, that wishes to have more robust fish in the open pens at sea, we don’t have the patience to wait for so long.”

— *CEO Asle Rønning*

Moreover, there is a risk concerning reputation. If Måsøval invests resources in many innovative projects that does not succeed, it might be perceived negatively by stakeholders. Also, there are high uncertainties concerning where the industry will be at in the future. Rønning points out that if the rules for licenses to operate changes, it might be too expensive to invest in land-based post-smolt. Rønning states that the most important factor for determining if Måsøval will go through with a project like land-based post-smolt is the economic return. Additionally, Rønning underlines the importance of dialogue with the authorities concerning possibilities for the future, and what will be granted permission.

For Måsøval, mortality has also been a problem, and by producing a larger, more robust smolt before it is put in open net pens might reduce the mortality. Hence, it will help Måsøval in achieving their strategy of further growth. The graph in 4.2 shows costs related to lice and mortality for the years 2012-2015. It can be observed that until 12 months in the sea the costs are quite low. After 12 months an increase in costs can be seen for all four years.

The idea is that if the time at sea is reduced, the salmon will avoid the “after 12 months” - period.

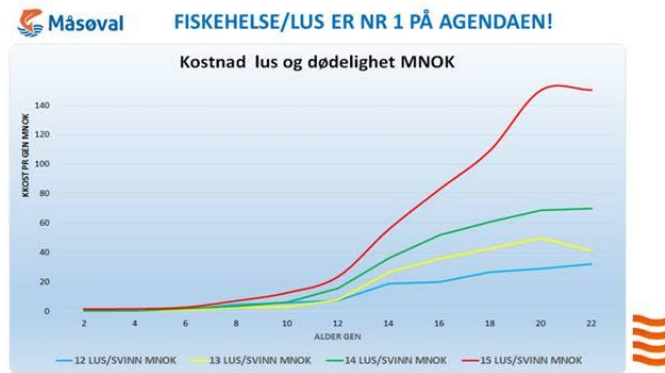


Figure 4.2: Lice and mortality costs

“This is a very tempting thought. Though it might not be that easy.”

— CEO Asle Rønning

Reducing the production time at sea will lower the risks for externalities beyond farmers control. Due to the high investment costs in land-based installation, the short-run solution is less risky and more agile.

Partners and Cooperation

The salmon farming industry is a quite young industry, and Måsøval underlines the importance of a mix of competencies in cooperation to drive the industry in the right direction. Many of Måsøvals innovation projects has its roots in cooperation with other actors in the industry.

Moreover, Måsøval has a broad network existing of suppliers, researchers, other farmers, and all the personal relationships established by key people in the firm. If Måsøval identifies a problem that needs to be solved, they search for knowledge and ideas in their network. Other times, it might be the suppliers that identify a problem that the farmers have not yet been aware of. In these situations, the supplier brings out an idea or solution so that Måsøval can test it in their production.

Måsøval cooperates with the local kindergarten named Rabben, in addition to Frøya high school. The aim with this cooperation is to be transparent with the local society to increase the understanding and establish curiosity for the industry among the children. Måsøval is a part of Blått kompetansesenter, which is a platform to link industry and academia to create a network of different actors working with fisheries and aquaculture. Also, Måsøval cooperates with Kråkøy Slakteri AS. This is to support the local industry and sustain local jobs. The relationship with Kråkøy Slakteri is of high value to Måsøval. The cooperation makes it possible for Måsøval to fulfill costumers demand. Also, the workers at Kråkøy Slakteri is very efficient, and have the ability to modify in short notice, which is important for Måsøval. Kråkøy Slakteri has earlier been in cooperation with SINTEF Fiskeri og Havbruk on a project to find solutions to slaughter salmon directly

from the wellboat. Måsøval acknowledges this cooperation and project as a good ability to see possibilities and solutions. Additionally, Måsøval sees the project as an important attribute to a sustainable industry.

In the short-run strategy for post-smolt, Måsøval has decided to cooperate with Botngaard AS. Together they will develop a semi-closed construction that will be placed in-shore, close to the land-based hatchery used today. The first salmon is estimated to be swimming in the new construction by May 2018. Botngaard AS is a firm that develops and distributes products made out of industrial textiles and tarpaulin to the aquaculture industry in Norway. These products are meant to prevent salmon lice to settle on the farmed salmon. Lately, the firm has invested in semi-closed systems. The firm is located in Bjugn, Norway in the same region as Måsøval. Since 2010, Botngaard has worked with semi-closed fish pens. Today, they deliver a solution based on a custom made “cloth” to cover the pen. This solution is a result of three large innovation projects in cooperation with farmers, suppliers and Sintef Ocean. Semi-closed systems have existed for a long time, and the principles they used in the 1980’s are the same as they use today. Though, the innovation takes place in the development of the technical installations. An installation may take a week, though an order will take about 4 - 6 months to finish. Botngaards vision is to reduce the time spent in open pens with 50%, hence from 16-20 months till 8-10 months. Through this system, the smolt will be able to grow in protected surroundings until the salmon reach a certain size (between 500 grams to 1,5 kilograms). When it then is released in the open pens, the salmon is robust, and better able to handle the environment at sea. They are expected to have a high growth rate and reduced mortality.

When cooperating in time-consuming projects with large investments, Måsøval establishes contracts to formalize the relationship.

“In projects including patents and other IP-rights, there is no doubt - a legal contract is needed to formalize the relationship”

— *CEO Asle Rønning*

Måsøval also has formal relationships with partners in the region to cooperate with fighting the salmon lice and cooperation concerning production zones. These relationships are characterized as friendly, as the results benefit all the farmers in the region. The informal relationships usually happen at an early stage in a project development, or when cooperation happens in the personal relationships established by employees in Måsøval. The cooperation with Botngård AS started out as an informal relationship. Though, as the partners now are investing in the project, formal contracts will be made. Rønning states that this is also due to new and smaller suppliers entering the project.

4.2.2 Lerøy Midt

Introduction and Background Information

Lerøy Midt AS is a fully integrated firm with 57 licenses to operate. They are based in the middle of Norway and have offices in Kristiansund and Hitra. Lerøy Midt is a subsidiary of Lerøy Seafood Group ASA (LSG) located in Bergen, Norway. LSG performs fish farming activities in three regions: West Norway (Lerøy Sjøtroll), Central Norway

(Lerøy Midt AS) and North Norway (Lerøy Aurora AS). LSG can trace its origins back to 1899. Until 1997, LSG was a family-owned operation. In 1997, a private placing was carried out. The firm has grown and changed along the way, as several mergers and acquisitions have been performed with other seafood companies. In 2002, LSG was listed on the Oslo Stock Exchange. Today, LSG has 3,800 employees. The Group's core business is the production of salmon and trout in addition to catches of whitefish, processing, product development, marketing, sale and distribution of seafood. LSG operates the entire value chain and delivers Salmon to 80 different countries all over the world. The Group has production and packaging plants in Norway, Sweden, Denmark, Finland, France, the Netherlands, Portugal, Spain and Turkey, and sales offices in the USA, Japan, and China.

Decision Making Process and Strategy Development

LSG has a vision that “We shall be the leading and most profitable global supplier of sustainable quality seafood”. The main focus has always been to deliver seafood of high quality. Additionally, LSG has an environmental vision of “Take action today - for a difference tomorrow”. With this vision, LSG fully intends to take initiative for environmental improvement that will benefit the environment, fish farming industry, and coastal communities. In 2016/2017, LSG implemented new values for the Group. These are Creative, Honest, Open and Responsible (Lerøy, 2017). There is a high focus on sustainability in LSG. The strategy is based on a lasting perspective which motivates utilization of coastal resources. This strategy requires the involvement of owners, employees, and suppliers, and LSG state that it is applied daily to the production. Production Manager Stig Nidar Selvåg is part of a group of executives who works closely with LSG. Selvåg says that their ideas and thoughts have a huge impact on the decision makers in LSG.

Sustainability

LSG is aiming towards a leading role in constantly improving the interaction between aquaculture and the environment by making it sustainable. The projects working with sustainable development is mainly based in the west of Norway, at the headquarter in the Bergen area. Though, Lerøy Midt has one man who is part of the board of LSG, who works with sustainable development projects. LSG have built up teams to support the local operations toward sustainability. An overview of these teams is presented below.

Advisory group for environment and safety Supports the production companies in relation to prevention of accidental release and staff safety. Standardizes operating concepts, technology and methods.

The fish health team Supports preventive work and ensures good routines for managing salmon lice, and ensures good fish health and welfare.

The RAS/post-smolt team Provides project management and support to the production companies when selecting appropriate solutions for environmental and more efficient operations, and shorter production time in open cage systems at sea.

The cleaner fish team Supports our six production plants for lumpfish and develops good models for optimal utilization of own produced and wild-caught cleaner fish to combat salmon lice at our fish farms.

The technology team Builds up Lerøy's own technological development team, with competencies related to ordering and in-house competencies for the improvement of current production concepts and development of new production technology.

International standards such as GLOBALG.A.P and ASC, along with standards developed in-house, has been useful for LSG in providing inspiration for and documentation of good routines and attitudes. LSG has been involved in the development of ASC since 2004, and in 2013 LSG was the first firm worldwide to be certified according to the ASC standards. LSG has a goal that all fish sold by the firm will be ASC-certified.

Lerøy Midt works with sustainability in all production levels. They have had a special focus on keeping the localities sustainable by not overusing the areas. Selvåg highlight the work they do regarding environmental control, and thorough analysis and deliberation across sections of the firm.

“Sustainable development has become governing for us as the regulations establish a pathway. As for example the traffic light system, which decides who (regions) can produce more.”

— *Production Manager Stig Nidar Selvåg*

Lerøy Midt is also actively involved in all parts of the value chain. This is in order to ensure supply of safe products and keep track on their sustainability performance. The involvement includes controlling and monitoring manufacturers and partners by specifying requirements for their quality systems and routines and carrying out analyses and monitoring operations. Because of this, LSG has achieved ASC "chain of custody" for its sales, distribution, and value-added processing chain. Further, due to their involvement, LSG is able to offer consumers full traceability of all products. Gladlaks.no is one example of this where consumers can go online and download information specific to the product they have purchased. Selvåg underlines the importance of how the Norwegian aquaculture is regulated and what this has meant for sustainable development. Other countries have tried to copy the "Norwegian model" without the regulations, which has not been very successful.

”There have always been disagreements concerning regulations, but if there hadn't been any the aquaculture would have had bigger challenges today.”

— *Production Manager Stig Nidar Selvåg*

The new traffic light system is aimed to stimulate sustainable growth. Selvåg says that Lerøy Midt is not satisfied with all the elements of the new system, but that they have explored how they can use it to their own advantage. As for now, Lerøy Midt is in a yellow zone indicating that they cannot increase production until the light turns green. The main goal now is to get the zone green as fast as possible.

Innovation

Selvåg asserts a high innovation rate in the industry due to the urgent need for new methods and solutions. Though, Selvåg argues that the innovative initiatives might be arriving too late, forcing the farmers to implement the solutions because of a shortage of optional methods.

“The challenge is that you try out new concepts before it has been widely tested, thus it may not work as planned. The development of new solutions should have been started 10 years ago!”

— *Production Manager Stig Nidar Selvåg*

The initiatives to new innovations arise both internally and from suppliers. Selvåg says that this varies a lot. Lerøy Midt has, together with Marine Harvest and Salmar, worked on how to improve the solutions for technology regarding not and open net pens. Selvåg says that today’s solutions are not good enough, thus the big three has to cooperate to higher their bargaining power of suppliers to make them improve the quality of the product or service. As the situation can become critical due to e.g. salmon escape, Lerøy Midt often sees that the suppliers use too long to come up with new solutions. On the other hand, there can be opportunities out of the farmers’ focus, whereas the suppliers come up with new solutions. In these situations, the suppliers turn to Lerøy Midt and challenge them to try new methods. Selvåg states that the decision on which projects they will participate in is based on what Lerøy Midt sees as most important at that instant. Concerning post-smolt, Lerøy Midt has come quite far. Selvåg claims that the technology is in place, but the costs are still high. The focus now is how to lower the costs.

”In the work with post-smolt, we are trying and failing, though we have come quite far and we have plans to continue the work. As the costs of bringing the production on land are high, the goal now is to lower these costs.”

— *Production Manager Stig Nidar Selvåg*

Hence, the development of post-smolt is crucial to get salmon that is more robust and resistant to lice. If Lerøy Midt succeeds with post-smolt, they estimate that 25-30% of production will be post-smolt. They do not see it as a game changer for the production process.

Challenges

Lerøy Midt has experienced a high pressure from salmon lice. In 2016, they had to empty two localities due to the impact of lice. Thus, the challenges with salmon lice have led to changes in strategy and production routines. Selvåg says that when the lice became resistant to chemical methods, it took more than two years for an alternative method to be developed.

Risk and Uncertainty

The highest risk for Lerøy Midt is external factors such as salmon lice. Since they are fully integrated they are not as focused on risks when it comes to suppliers and partners. Additionally, they have a broad resource base which decreases the risks of participating in innovative projects.

Partners and Cooperation

LSG is a partner in SFI CtrlAQUA, a center for research-based innovation, which aims to develop and document a range of post-smolt concepts. In 2015, Lerøy Midt cooperated in a project with Nofima. They investigated if smolt could be kept on land longer with RAS-technology. The results from this project showed that post-smolt have a significantly higher growth rate than ordinary smolts. Additionally, post-smolt withstood today's treatments against salmon lice better than ordinary smolts. The report concluded with post-smolt being profitable (?). Lerøy Midt cooperates with other farmers in the region, though these relationships are based on production processes to develop new, more efficient methods.

”The three large ones (red.an. Marine Harvest, Lerøy and Salmar) cooperates if we sense inadequacy of solutions in the market that meet the requirements of fish welfare, lice, escapes, and reputation. But when it comes down to the last cent 10, there is an every-man-to-himself mentality.”

— *Production Manager Stig Nidar Selvåg*

With post-smolt, all the development and production is done internally. Though, Selvåg explains they had an incident in the beginning were the suppliers of roe were not able to deliver to the right time. Lerøy Midt solved this by turning to suppliers outside of Norway, in this case, Iceland.

“In times with reorganization due to new innovations, the suppliers might not be able to deliver what we are asking for. Thus, we turn to other suppliers outside of Norway. Eventually, the Norwegian suppliers speed up and follow.”

— *Production Manager Stig Nidar Selvåg*

Selvåg underlines that there might be too little competition among the Norwegian suppliers to the aquaculture industry. He suggests that it might be due to the industry being quite small compared to e.g. the oil and offshore industry. Selvåg says that they often see one or two suppliers that outperform the others. Hence, it makes it difficult for the farmers to ask for new solutions and improvement. Selvåg claims that the optimal would be to have many suppliers to choose from to create a competitive environment where it is easier for the farmers to acquire change. As for post-smolt, there is a degree of secrecy and competition, as there is an advantage for the farmer that manage to produce post-smolt with low production costs.

”There is a direct upside with the production of post-smolt. The main challenge is the high production costs. The farmer that manage to lower these costs have a huge advantage!”

— *Production Manager Stig Nidar Selvåg*

As Selvåg implies, Lerøy Midt wants to cooperate with small and medium-sized firms and invites them to participate in projects. Though Selvåg tells that these firms seldom participate. Selvåg suggest that this might be due to the 3 big ones (Marine Harvest, Lerøy and Salmar) have more resources, and hence better capacity to carry out developing projects.

“Their attitude (SMEs) are more like: let the big ones fix it! And then they wait to receive the documents and result later.”

— *Production Manager Stig Nidar Selvåg*

On the other hand, when it comes to the everyday production, all firms in the region cooperate. These relationships are informal and include production zones, regions, service boats etc.

LSG wants to facilitate knowledge sharing between local farmers and the surroundings. Selvåg can tell that knowledge transfer internally has become better during the last couple of years, and he considers it as good today. As for external knowledge sharing, Selvåg suggests that the industry has gone from innovating individually, to now becoming more open and cooperative. As for example, Lerøy Midt has a close dialogue with Sintef regarding which path the industry should develop, and how growth is best done. Additionally, Sintef proposes the biggest challenges the industry needs to be aware of. This cooperation helps to make a more thorough consideration before implementing new technology, which again lowers the risk and uncertainty. Though, there are still exceptions where things are developed too fast and, hence do not serve the purpose as they were meant. But Selvåg states that all over the industry has become more knowledge-based.

There are not so many Gyro Gearloose solutions as before. The industry has become smarter and more developed. It is all about the way things are done. Every part of the value chain has become more professionalized, and the development of new technologies as well.

— *Production Manager Stig Nidar Selvåg*

The cooperation with partners is characterized by both formal and informal relationships. Especially the relationship with suppliers is formalized. Which means they have legal contracts between the parties. These contracts are valid for two to three years and provide instructions for how the cooperation, follow-up, and meetings will take place. Cooperation in clusters such as NCE is also formalized. Additionally, Lerøy Midt cooperates ad-hoc in development projects. These partnerships are sometimes informal. Though, most of the informal relationships are between farmers. Selvåg presents a project Lerøy Midt is working on regarding how to transport fish as gentle as possible from cage to wellboat.

In this project, one of the farmers came with a possible solution to a problem which they wanted to test out. And, Lerøy Midt decided to take part in its reference group. Most often this kind of cooperation happens between the actors in the same region.

“Though we are working on a regional level, it is clear that when Marine Harvest, Lerøy and Salmar meet together with the technological environment in Trondheim, you may say we aren’t that far from a national level.”

— *Production Manager Stig Nidar Selvåg*

Selvåg underlines the importance of having small and medium-sized firms in the industry, especially when it comes to the development of new solutions. He further suggests that the industry has reached a maximum level of consolidation.

“The industry becomes poorer if all the 10-12 license companies are selling themselves out. Though, it is the market that decides.”

— *Production Manager Stig Nidar Selvåg*

Lerøy Midt also sees a larger amount of workers coming to the aquaculture industry from the oil- and gas industry. These workers are mainly technical (i.e. hydraulic, welding) and not so much on site at sea working with the salmon. Selvåg explains that the recruitment has been quite good lately. They find it easy to get hold of competencies needed, and most of them are very motivated for the job.

4.3 Trøndersk Kystkompetanse

In this section, data from the interview with Trøndersk Kystkompetanse (TKK) is presented. This interview was performed to get better view and understanding of how the firms in the region operate.

TKK is a network for firm- and industry development in the area of Hitra, Frøya, and Snillfjord. The work by TTK is supposed to contribute to sustainable value creation in the firms. Further, TKK wants to connect firms in the region to expertise on a national level. Both Måsøval and Lerøy are part of the TKK network. Heidi Glørstad Nielsen in TKK was interviewed after the case interviews. Nielsen is Project Manager and Senior Consultant at TKK. She was willing to participate in this study with an overview of how TKK sees the cooperation among the farmers in the regions concerning green innovation. The main driver for green innovation seems to be the more efficient use of resources to reduce production costs and fish welfare. The farmers in the region wish to produce on the nature’s premises. Nonetheless, regulations impose the industry to innovate. All these factors drive the need to come up with new, more sustainable solutions. Nielsen observes that more and more suppliers are entering the market. Further, she states that the suppliers innovate in line with the necessity of the farmers. Whereas the farmers innovate in line with environmental concerns, fish welfare, and production efficiency.

“The farmers desire to develop smart production to earn more money so that they can spend more on research, development, and innovation.”

— *Project Manager Heidi Glørstad Nielsen*

Often, initiatives for innovation arise either by farmers “on the ground”. Where the workers have hands-on experience and know the production system and fish well. Or, innovation derives from the suppliers where they find solutions for the needs of farmers.

Nielsen sees the region as quite attractive for new employees. Additionally, the large firms have established offices in the cities, making themselves more available to needed competency.

The farmers are very committed to not overuse the environmental resources. Additionally, the aquaculture is important in building the local society.

“All firms in the industry are committed to having a reflected perspective, and responsibility for sustainable development - whether they want or not.”

— *Project Manager Heidi Glørstad Nielsen*

The immense environmental challenges for the industry has led to strict regulations. Certification is also contributing to raising the quality of production.

“Governance, innovation and a growth of five times the production level today motivate to think outside the box.”

— *Project Manager Heidi Glørstad Nielsen*

Salmon lice have been one of the biggest challenges for the aquaculture. Post-smolt is a possible solution to moderate the impact of salmon lice. The challenge with post-smolt is the costs of having it on land. These costs include construction and energy for production as you do not have the natural currents in the ocean to circulate the water.

Nielsen points out that the industry is very agile, and respond to changes fast. She suggests that reasons for this might be, on the one hand, that the industry share experience with each other. This is crucial since they are located close to one another, and, since emissions from one farm affect the others in the region - if one locality is infected with diseases, it might easily spread to the others. On the other hand, salmon farmers are used to working with a changing environment, nature, and hence used to react due to uncontrollable externalities.

“There is a lot of tacit knowledge stored in the farmers. The people of the Norwegian coast are used to turn around as they are working with mother nature.”

— *Project Manager Heidi Glørstad Nielsen*

There are cultural differences due to the size of the firms. TKK observe that the larger ones are better at cooperating with each other. The SMEs are family owned and maybe more traditional in their way of doing business. The common denominator is that all deliver fish. There are also a lot of informal cooperation among the farmers in the region. This is because they have used each other for a long time and the relationship is incorporated in their daily production. The farmers have a high degree of trust among them. They know each other well, and they know which areas they can trust and which they need to be more alert.

“The farmers cannot operate selfishly, they depend on each other and has to work together for a common goal.”

— *Project Manager Heidi Glørstad Nielsen*

The largest firms carry out internal R&D. Sees this as a necessity to lead the industry in the right direction. The firms are quite impatient. Though, subsidized research has guidelines that must be followed by the farmers. The smaller firms are often invited with the larger ones on development projects, still, they turn down and rather sit back and wait for the results. The largest firms use TKK as a facilitator when they want to cooperate with other actors in the industry. Måsøval participates in board meetings and projects.

Larger and more complex projects are often formalized. If the relationship includes research the parties are fast to sign a legal contract. They crave sovereignty. She also says that the employees are very loyal to their respective firm.

As the farmers are doing different things, there might arise conflicts regarding how to reach their common goal. Different opinions among the farmers in this area. She sees competition among the farmers concerning the development of post-smolt.

“They all know that everyone is looking at the potential for post-smolt. And, they all keep their cards close to their chest. They want to keep it a secret. Why? They want to be first.”

— *Project Manager Heidi Glørstad Nielsen*

Concerning digitalization, there is an upheaval going on. The aquaculture industry has started digitizing processes in their production. This is a restructuring that is done gradually. The industry is not hesitating the use of digitalization, and today, the fish are fed from land by using computers.

Nielsen stresses that regulations have much to say when it comes to the future development of the industry. There is a high uncertainty concerning land and replacements. Additionally, diseases are a high risk for the farmers. Also, global governance will affect the future. In Norway, the industry is not that popular with the stakeholders. This is a major challenge for the farmers.

“The aquaculture industry will not receive any audience reward. There is too much capital. The Norwegians hate the industry.”

— *Project Manager Heidi Glørstad Nielsen*

Moreover, we see a growth in the world population, and an increasing middle class, with a need for more supply of food.

The unique with Norway is the advantages given by nature - long coastline and Gulf stream. Norway also has strict regulations that hinder depletion of resources. Also, the industry in Norway has a good reputation globally, which will be important to sustain and build on further. Moreover, it is a small country, but with good facilities for education and research, which contributes to sustainable improvement.

Chapter 5

Discussion

In this chapter, the empirical findings from Chapter 4 will be discussed together with the conceptual background and theoretical framework from Chapter 2 in order to answer the research questions of this thesis. The discussion is divided into five sections. The first will try to answer and investigate the first research question¹ of this thesis. Then, the next section will discuss and propose how firms can use external knowledge sharing to enhance green innovation processes, hence answering the second research question². Thereafter, implications for theory, managers, and policy-makers will be discussed. Then, limitations of the thesis, and, lastly, suggestions for further research.

5.1 Creating a Competitive Advantage

As Porter (1986) states, to achieve competitive advantage, firms can either differentiate or lower their costs. Moreover, the resource-based view underlines heterogeneity in terms of resources and internal capabilities as an important factor to create competitive advantage, whereas the relational view sees firms relations across firm boundaries as an important source to create competitive advantage. This section will discuss how firms can create competitive advantage by implementing green innovations, where Porter's theory, resource-based view and the relational view is used as theoretical rationales. Måsøval and Lerøy Midt have both implemented sustainability as one of their core strategies. The next sections will discuss how firms use green innovation processes to create competitive advantage. based on internal and external factors, long-term and short-term perspectives, and in terms of the double externality effect.

¹How do firms use green innovation as a strategic tool to create competitive advantage?

²In what way do external knowledge sharing contribute in green innovation processes, and how can it be used as a strategic tool to create competitive advantage?

5.1.1 Differentiation

In farming of Atlantic salmon, the product is merely the same. As Måsøval states, the farmer's main goal is to produce high-quality fish, and this is the same for all the operators in the industry. As long as the regulations are as today, the farmers will produce within the same environmental limits. This indicates that differentiation has not been an extensive strategy in the industry. It is argued by scholars that high stringency of regulations makes it hard for firms to differentiate (Aguilera-Caracuel and Ortiz-de Mandojana, 2013). Since all the Norwegian farmers have to follow the same regulations, it might be difficult for firms to differentiate based on the product. The regulations of the industry have indeed shaped the strategy formation of firms. Selvåg states in 4.2.2, that without the regulations the industry would have had bigger challenges today, and that the regulations operate as a guideline for how the firms should develop. Nonetheless, it seems like there is a consensus in the industry that the regulations have had a positive effect historically. Hence, the Norwegian government has managed to create shared value with their approach towards the aquaculture industry. This is in line with Porter and Van der Linde (1995) who states that regulatory push will guide firms to make better decisions in the innovation processes. Still, it seems like regulations have weakened firms incentives to differentiate. It is also argued that regulations may lead to more defensive green strategies rather than proactive ones (Lin et al., 2014).

As the industry has struggled with challenges such as lice and diseases, the reputation has become quite fragile. TTK points out that Norwegians are more skeptical to the industry than international stakeholders. As expressed by Måsøval, the industry has an unfairly bad reputation. Improving the image of the industry is a reaction to the bad reputation, hence it can be seen as a defensive strategy. Scholars have found that many firms investing in green innovations do it to market their image as sustainable, and thus, differentiate from competitors. In the Norwegian aquaculture industry, it seems like the image has not been a source of differentiation, but rather it has been important that the industry as a whole is seen as sustainable among stakeholders. The incident with lice in 2016 that affected Måsøval and Lerøy Midt had an impact on the whole industry's reputation. It appears that the firms in the industry support each other when it comes to showing how sustainable the industry actually is and improve the image of the industry as a whole.

Both case firms are certified voluntary by GLOBALG.A.P. and ASC. LSG has been involved in the development of ASC and was the first firm to implement the standards. Thus, it can be seen as a proactive action to create an advantage through green initiatives. Moreover, Lerøy Midt underline that it is important for the firm that all parts of the value chain are sustainable in their production. This is not pointed out as a strategy to differentiate, but rather a concern for the environment they operate in and an awareness around the impact of production on nature. This finding implies that the industry might use green innovations due to environmental concerns rather as a strategic tool to differentiate. Måsøval makes it clear that they do not focus on differentiation in their sustainable strategy, and state that neither do the other firms in the industry. Måsøval further argues that it will stay this way until the market becomes smarter.

The new traffic light system divides the coast into 13 zones, whereas growth is governed by the number of lice in each zone. The new system can create incentives for the firms to differentiate from firms in other regions. Today, the region the case firms operate

in is on hold (yellow light), which means no growth until green light. Lerøy Midt state that one of their main goals now is to change the lights to green as soon as possible to enable growth in the region. This is a common goal for all farmers operating in the zone. Lerøy Midt implies that they are not happy with the new system, but has managed to find ways they can use it to their advantage.

One thing that is worth noticing is that the new system can do more harm to the smaller firms in the region. This is because these firms often only operate in one region, whereas the larger ones, such as LSG, operates in many regions along the Norwegian coast.

5.1.2 Lower Costs

Traditionally, green innovations are often associated with higher costs, and it is, therefore, difficult to use green innovation to create a cost leadership. Though, Porter and Van der Linde (1995) underlines how allocating resources more efficiently can lower these costs. For the aquaculture industry, it is important to have an optimal rotation to lower production costs, and green innovations can be an enabler to achieve this.

The focus and competition among firms in the aquaculture industry have been on reducing production costs, and both case firms imply that this is their strategy as well.

This is also implied as one of the main reasons for secrecy regarding the optimal production of post-smolt in the industry.

Post-smolt is an innovative process that is motivated by both opportunities in protecting against non-controllable factors and create optimal rotation. Optimal rotation is important due to maximize the limited licence to operate decided by the government. Because there is no limit on the license to operate on land, it can be profitable to produce more and bigger fish before it is released in open net pens. Both case firms indicate that they feel uncertain about how the regulations will be in the future. If the government makes changes in the MAB-restrictions, it will have an impact on optimal rotation. Hence, investing large amounts in land-based constructions for post-smolt can become unprofitable. Though, it seems like the risk is higher for Måsøval than for Lerøy Midt. Måsøval states that they are looking at different strategies for how they will improve the optimal rotation. Additionally, they are not yet sure if they are going to invest in the land-based production of post-smolt. On the other hand, Lerøy Midt is clear that they will attempt to produce post-smolt on land, and that they have had good success so far. Lerøy Midt points out that there is a race in decreasing the production costs, and that post-smolt is a great opportunity to do so.

As it has been observed, the focus of the farmers has been on short-term solutions rather than long-term due to high production costs. Both case firms stress the uncertainty of future regulations as a risk factor. Dangelico and Pujari (2010) suggest that regulations present opportunities for risk minimization, though the findings in this thesis imply that the changes in regulation are a risk factor for the firms operating in the industry. Additionally, historically, the regulations in the industry have had a huge impact on the structure and development of firms. As both Måsøval and Lerøy Midt argues, there are high risks and high costs regarding investment in land-based constructions when not knowing if there will be an ease of requirements concerning license to operate at sea.

Moreover, proactive innovations have mainly emerged from the suppliers. Thus, this might be a result of regulations limiting the farmers potential of growth and potential to create economies of scale. Måsøval underlines that most production costs are fixed, so

without the ability to create economies of scale, it is hard for the farmers to lower these costs with today's solutions.

5.1.3 Heterogeneity

The industry has had many consolidations. This has resulted in heterogeneity regarding firm size and internal activities as explained in 4.1.3. As firms are becoming more and more vertically integrated with increased internal activities is, according to the resource based view, a possible source of competitive advantage. Despite this, the report by Olafsen et al. (2002) indicates that the larger firms in the industry do not focus on long-term innovations as much as hypothesized. This is because they have high production costs, and rather focus on short-term solutions to lower these.

Lerøy Midt is a larger firm than Måsøval and controls a bigger part of the value chain, hence, they might have an advantage based on internal resources to implement green innovation. By integrating the value chain, Lerøy Midt has access to knowledge in all parts of the production. Historically, suppliers have been the link between farmers and researchers. By integrating the supply chain, Lerøy Midt has reduced the gap between them and researchers, and made it easier for Lerøy Midt to search for knowledge internally. For Lerøy Midt, this can be a source of competitive advantage. Despite that integration of the value chain can result in better cooperation, it might foster group-thinking, lower the cognitive distance, which can decrease the innovation rate of the firm. An important factor to create new ideas is to have inputs from heterogeneous environments. As for Lerøy Midt, only focusing on internal resources can limit their ability to generate new ideas. On the other hand, easy access to sources of knowledge can increase Lerøy Midt absorptive capacity. And, integration can help in creating a green shared vision. As a result, this can create trust and stimulate resource exchange across units (Noteboom, 2002).

The suppliers have historically been the main source of innovation in the industry. As argued by the resource-based view, inputs from suppliers are not a source of advantage since they are available to all competing firms, and the price for buying the product is the same as the economic value it creates. Hence, it is difficult for farmers to create a competitive advantage based on the solutions delivered by suppliers. Though, both case firms stress that the innovation rate in the industry is high and that suppliers come up with solutions all the time. Måsøval states that it is hard to choose which projects to engage in. Absorptive capacity will, in this case, be important for the decision making of firms.

Moreover, LSG has established teams to work with sustainable development projects 4.2.2. But, these teams are located in the Bergen area far from the site in Trøndelag. Today, Lerøy Midt has one person who is linked to these groups, but the distance from the people working on the farms and the decision makers might be too big. In the interview, Lerøy Midt state that they mainly focus on improvements in production, and not on new radical green innovations.

Internal resources as a source of competitive advantage are well known, and knowledge is seen as one of the most important capabilities for innovation Nonaka (2000). Though, green innovation is seen as more complex than ordinary innovation activities. None of the case firms in this study underlines regulations as the main driver for green innovation. Instead, both firms stress the environmental challenges and the importance for the aquaculture industry to take a proactive lead in sustainable development. TTK also support

this statement. As stated in 2.2, Chen et al. (2012) argues that only internal factors foster proactive innovations. Måsøval is quite clear in their strategy to take a leading step in the right direction. This is despite the size of their firm.

5.1.4 The Role of Partners and Cooperation

Green innovation is seen as more complex than ordinary innovation activities. Therefore it may be challenging for firms to only use internal resources and knowledge to come up with green innovative solutions.

It seems like firms in the Norwegian aquaculture industry are aware of their spillovers in both the diffusion and innovation phase, and that they do not see this as a problem the same way as Rennings (2000) suggest. Though, as the industry is highly regulated it is hard to state whether the regulations have served positively to decrease the effect of the double externality problem, which would be in line with Rennings (2000) theory. As the government has stated, no growth until it is sustainable. Thus, the firms might see their spillovers as investments in the long-term to enable growth for the whole industry, and hence have a positive mindset towards investing in technology and processes that give positive spillovers the whole industry can benefit from, despite that the costs are laid out by the respective firm alone. Hence, despite the fact that the industry is seen as short-term planners, they are forced by the sustainable strategy to look at long-term investments. This can be a source of competitive advantage in the future, as they are limiting the harm on the environment and not overusing the natural resources. In addition to regulations enabling this long-term focus, it can be discussed that the openness and the culture of sharing knowledge and resources in the aquaculture industry has contributed to the farmers' ease of producing positive spillovers for other firms. Though, in the interviews, it is not discussed how the farmers respond to positive spillovers to other industries. Nonetheless, it has not been discussed whether the new traffic light system might decrease the firms will produce positive spillovers to other regions.

Moreover, having a fully integrated value chain can decrease transaction costs of trading assets across firm boundaries, as repeated transactions with a small set of suppliers can lower these costs (Dyer, 1997). In addition, an integrated value chain can facilitate extensive information sharing, which reduces asymmetric information and hence reduce transaction costs (Dyer, 1997). Though, Lerøy Midt states that all relations with suppliers are formalized by time-limited contracts. Formalized contracts generate transaction costs. Lerøy Midt expresses that the suppliers' sustainable production is monitored. This is also an activity that increases the transaction costs. Also, despite the industry being important for Norway, it is still on a low scale compared to the oil and gas industry, hence the marked for suppliers is limited and it is not easy for them to achieve economies of scale. Both case firms cooperate with suppliers, yet this is either by farmers requesting a product or service from the suppliers, or the suppliers presenting a new product to the farmers they can test out in their production. The impression is that the suppliers and the farmers rarely innovate in cooperation. Due to all these factors, despite Lerøy Midt having the advantage of a fully integrated value chain, they might not be aware of how they can use this advantage to utilize their transaction costs. The traditional independent operators are characterized as open and willing to share knowledge. The industry has also been cooperative, and both case firms stress that firms in the industry help each other, especially when it comes to the

defeat of salmon lice. This is mainly because an outbreak of lice can easily spread to other locations nearby. TTK observes that there is a high degree of trust between the farmers in the industry. It is clear that the relationships have been established through generations, and that the farmers know each other well. Lerøy Midt cooperates with Marine Harvest and Salmar in many of their projects. They are the three largest operators in the region. Lerøy Midt points out the situation where they invite the smaller farmers³ to join projects, but where the smaller farmers reject and rather wait until the results are available for them to use. TTK also notices that the smaller firms do not participate in innovative projects, but wait for the results. Historically, the Norwegian aquaculture industry has been characterized by a learning-by-doing culture, whereas successful product or processes have resulted in other actors in the industry copying the solution. One reason is that the smaller firms do not have the resources to take on many projects and at the same time manage their daily production, hence they leave the work of development to the larger firms with a stronger resource base. Lerøy Midt stresses the importance of the smaller firms participating in projects to create diversity among the firms. The smaller firms often see things differently. This is also an important factor for generating new ideas, as heterogeneous firms may create more value by sharing their knowledge and resources across firm boundaries. It is important to maintain a cognitive distance among the partners in the region to prevent the innovative steam from collaboration to die out.

The suppliers have historically been the main source of innovation in the industry. These innovations are available to the whole industry. As argued by the resource-based view, inputs from suppliers are not a source of advantage since they are available to all competing firms, and the price for buying the product is the same as the economic value it creates. Hence, it is difficult for farmers to differentiate based on the solutions delivered from the suppliers. Måsøval has tried out several sustainable solutions presented by suppliers. They underline that it is important for them as a firm to pull the industry in the right direction. Testing prototypes has a negative cost. Måsøval states that if they are lucky, development projects generate zero costs, indicating that there is a high price that comes with these projects. As mentioned, Måsøval does not use differentiation as a strategy, so the reason for taking on these development projects in cooperation with suppliers is not in that context. When asked why they take on these projects, Måsøval answers that they want the industry to develop in the right direction, which indicates that environmental concerns are of high priority for the firm.

As suppliers are highly innovative and developing technological complex solutions, the transaction costs are, according to Williamson (1989), also high due to the need for formalization. Thus, according to Dyer (1997), firms can achieve both high asset specificity and low transaction costs. And, as they underline, if firms understand how to achieve this, it can be a source of competitive advantage. Hence, the choice of safeguard will influence the generation of transaction costs.

It seems that the relationships among different farmers are more informal than the relationship with suppliers. This is believed to be because of the high rate of change in the industry, which results in the firms not having the time to formalize, but rather need to act. Moreover, it can be the culture of openness and sharing among farmers that still is embedded in their daily production. TTK calls attention to the Norwegian aquaculture industry

³independent operator or horizontal integrated as presented in section 4.1.3.

being very agile. As people from coastal areas and fishermen are used to working with the changing nature, they may be apt to deal with changes efficiently. Lerøy Midt states that suppliers sometimes offer solutions too late and that they are not always able to adapt as fast as the farmers want. The pace of change due to non-controllable factors is believed to be a reason for the industry taking on more incremental innovations rather than radical. The incremental innovations are easier to adapt to an existing production process, and the costs and risks are not as high as if the radical innovation is not suitable for the environment the farmers operate in. As argued by Bartlett and Trifilova (2010), incremental innovations are as important when it comes to creating green innovations as radical innovations are. They found that incremental innovations arise from technical issues within the firm and that these stimulate green innovations that improve already existing product or processes. Both case firms express that many of the innovations from suppliers do not work as good as planned. This is often due to biological concerns not taken into consideration in the development of the innovation. Moreover, as the firms operate in an environment with non-controllable factors and a culture based on learning-by-doing, it falls naturally to precede a defensive innovation strategy to respond to external changes. It is difficult for the farmers to foresee the environment in the future, and hence it is risky to take on proactive green innovations.

5.2 External Knowledge Sharing

In this section, it will be discussed how external knowledge sharing affect green innovation processes. First, the importance of trust will be discussed, and thereafter, external knowledge sharing in an open environment.

5.2.1 The Importance of Trust

The Norwegian aquaculture has a tradition of sharing knowledge and expertise with each other. The farmers' systematic use of knowledge has made it possible to develop an Atlantic salmon that is unique with its high growth rate and low maturity. Many of the workers in the industry are closely related to nature and respects it highly. Since the production of salmon creates negative spillovers for the environment, the actors in the industry have cooperated to find better solutions. This is because spillovers from one farm will most likely affect the other farms in the region in the short-term. In the long-term, it will affect the natural resources the industry is dependent on⁴. As discussed in the last section, this is linked to the double externality effect. In the industry, the farmers together contribute to lower the negative spillovers from production by cooperating.

Cooperation between Competitors

In a region, salmon farmers from different firms are located close to each other. Because of this, diseases, for example, can easily spread between the localities. Thus, the farmers are dependent upon each other to prevent diseases or other non-controllable negative externalities. TTK states that the farmers in Region Midt cooperate in their daily production.

⁴Resources such as quality of the seawater, temperatures, extreme weather and algae.

However, TTK observes cultural difference due to the heterogeneity of the firms. TTK argue that the larger firms are better at cooperating with each other, whereas the smaller are suggested to be more traditional in their way of doing business. To help to analyze the in-depth interviews with the case firms of this study, two word-clouds were made⁵, one for each firm. Interestingly, Lerøy Midt had words like cooperation, development, challenges, production, and technology standing out, whereas Måsøval had words like production, price, and cost. This supports the statement of TTK that the larger firms are more focused on development and collaboration than the smaller firms.

TTK further state that there is a lot of informal cooperation among the farmers. They say this is because they have used each other for a long time and that the relationship is incorporated into the daily production. Moreover, the farmers have a high degree of trust⁶. Regarding the theory of trust, Dyer (1997) suggest that firms can select partners based on ex-ante trust or from known communities. It seems clear that the aquaculture industry has a long tradition of cooperating, thus the firms know each other well. This has made it possible for the farmers to develop trust over a long time. In today's changing markets, the established relations and trust in the Norwegian aquaculture industry vulnerable to new technology, centralization, and new competencies, though these aspects will not be discussed further in this thesis.

Cooperation in the Supply Chain

The aquaculture industry started out with the only family-owned operators, but due to regulations that have resulted in consolidations, the firms in the industry today are very heterogeneous. Måsøval is a typical horizontal integrated firm⁷ that has done a couple of acquisitions, but are still managed by the family who founded them. Typically for these firms is the short distance between employees and the decision makers. Lerøy Midt, on the other hand, is a part of the Parent-firm LSG which is a typical vertical integrated firm. With the perspective of transaction cost theory, this implies that for Måsøval outsourcing is less costly than performing the activities in-house, whereas, for LSG, who manage the whole value chain in-house, it generates more costs to outsource. Lerøy Midt states that by being actively involved in the value chain, they are able to ensure safe products and keep track of their sustainability performance. This is done by controlling and monitoring manufacturers and partners. The controlling activities generate costs for LSG. Hence, it seems that regardless of being fully integrated, there are transaction costs related to the cooperation. The need for control and monitoring is believed to derive from the lack of trust between the partners. It is further believed that the lack of trust is a result of not having a shared green value. If the partners have a shared green value and common understanding of the importance of sustainable development, the costs regarding controlling and monitoring could have been avoided. It is believed that a relation built on self-enforcing agreements will favor both Lerøy Midt (i.e. reduced costs) and the partner (i.e. creating trust). By collaborating closely with its partners, sharing of knowledge will occur. This can enable a shared green vision and create trust among the partners. Nonetheless, this

⁵These are to be found in Appendix A

⁶As TTK states in the Empirical findings, the farmers know each other well, thus know which areas they can trust and which they need to be more alert.

⁷This is explained in section 4.1.3

can improve the efficiency in production as suppliers are better able to develop resources needed that are in line with the requests from the farmers. By looking at the fact that the industry is experiencing low technical progress⁸ and the fact that most innovations stem from the suppliers, the knowledge sharing between the farmers and suppliers will be of crucial importance to be able to increase the technical progress in the industry. To achieve this, the farmers must build up trust with their suppliers. Dyer (1997) suggest three ways a firm can increase trustworthiness. The first is to demonstrate through behavior a commitment to future interaction. This means that the farmers should ensure the suppliers that they will commit to cooperate in a long term. Lerøy Midt states that the suppliers are not always able to deliver the solutions that the farmers need. The reason being a too narrow market for aquaculture in Norway which gives the suppliers bargaining power. A stronger commitment between the partners might enable for more cooperation in the development of solutions. This way of developing new solutions might favor a more incremental development of green innovations. This is because the parties are able to test the solutions as they go, adopting the learning-by-doing approach already well established in the industry. By using this approach the uncertainty and risk of the green innovation processes are lowered. This will, in other words, be a more agile method to cooperate. Radical innovations are often seen as more favorable than incremental innovations, though the researcher argues that when it comes to the complexity of green innovations, incremental development is favored to reduce risk and uncertainty regarding the environmental impact of the process developed. Incremental green innovation will also motivate the parties to commit to future interaction. The second proposed by Dyer (1997) is to increase the amount of knowledge sharing. The concept of absorptive capacity will be of importance for the parties to be able to assimilate and use new knowledge. Moreover, it is important that the parties have a degree of cognitive distance between them. Because the value chain of Lerøy Midt is fully integrated, cognitive distance might not exist to the same degree as if the activities had been outsourced. Hence, a fully integrated value chain might extract the innovative steam from the collaboration. From the empirical findings, the researcher gets the impression that Måsøval has been focused on establishing trust with partners outside of the firm boundaries. This is illustrated by Måsøval being a pilot for new projects developed by suppliers. Hence, signaling to the suppliers that they believe in their solutions. By testing the products developed by suppliers the parties are able to share knowledge and create trust. Though it is believed by the researcher that the rate of innovation will increase if the parties cooperate earlier in the process because of the complexity of green innovations. Thus, this will stimulate a continuous sharing of knowledge throughout the development of the new solution. The third way suggested by Dyer (1997) to increase trustworthiness among firms is to employ self-enforcing safeguards to govern the relationship. This means that trustworthiness can be enhanced by for example creating shared green value. It can also be done by using reputation as a safeguard, as reputation will affect all the firms involved. To sum up, by creating trustworthiness the firms involved will more likely intensify the sharing of knowledge, and, hence, be able to generate new green innovative solutions at a higher rate. It is believed by the researcher that another important factor to enable trustworthiness, is for firms be more open. This will be discussed further in the next section. Based on this discussion two proposals are made by the researcher: P1: firms in green

⁸The industry is not able to innovate at a rate that give lower production costs

innovation processes should employ self-enforcing safeguards to enable trustworthiness, which will increase the knowledge sharing among firms. P2: firms in green innovation processes should prioritize incremental green innovations in cooperation with suppliers to lower risk and uncertainty in the innovation process, and to be agiler and able to adjust to requirements from different stakeholders⁹.

As stated, green innovations are believed to be more complex than ordinary innovations. Because of complexity, assets linked to green innovations are believed to be specialized. As stated by Williamson (1989), the more specialized the assets the higher transaction costs. Thus, to decrease transaction costs regarding green innovations, Dyer (1997) suggest firms use self-enforcing safeguards. Moreover, Dyer (1997) point on trustworthiness having a negative correlation with transaction costs. In other words, transaction costs lower as the degree of trustworthiness arise. The empirical findings imply that there is a high degree of trust among farmers in the aquaculture industry. As trust has been built up through generations, there is a potential for farmers to take advantage of this to create self-enforcing agreements in innovation processes. Farmers in the industry often start off projects without any agreement and then change to third-party enforcement of agreements later in the process when the innovation projects become more complex and include high invest cost. In cooperation with suppliers, legal contracts are established. The problem with third-party agreements is the distance created between the parties due to less transparency and openness. As expressed in the empirical findings, the industry has not been able to innovate at the desired rate. This has resulted in technical inefficiency and high production costs. To gain a higher innovation rate, it is of crucial importance to cooperate and share knowledge with external partners to gain new insight. Trust can be an enabler to stimulate resource exchange and collaboration. Therefore, trust is an important factor to increase the innovation rate. Additionally, collaboration across firm boundaries enables shared a green vision. A green shared vision will act as a driver for green innovation processes. Nonetheless, it is believed that cooperation with farmers and suppliers will lower the double externality problem. This is because the costs are spread across all the firms cooperating and not by one firm alone.

Moreover, creating an environment of trust and knowledge sharing can cultivate transfer of tacit knowledge. Transfer of tacit knowledge is hard for competitors to imitate, and, hence, the firms can create competitive advantage by building strong relations based on trust.

By investing in such relation-specific assets, firms can create complex interfirm structures that are hard for competitors to imitate (Dyer and Singh, 1998).

Lerøy Midt stresses the fact that the suppliers are not as agile as the farmers, and that solutions arrive too late. As Lerøy Midt state, the farmers in the region often come together to achieve a higher bargaining power of suppliers if they are not satisfied with the products they offer the industry. If the farmers and suppliers manage to develop relationships based on self-enforcing safeguards, it can enable collaboration and knowledge sharing that will increase the rate of innovation.

⁹These stakeholders can be researchers, biologists, policy-makers, local society, environmentalists, etc.

5.2.2 Operating in an Open Environment

The development of post-smolt is seen as an incremental green innovation. Interestingly, regarding post-smolt, it seems like the roles have shifted when it comes to cooperation. The cooperation between the farmers is not prioritized, but rather secrecy. Both case firms are cooperating with suppliers when it comes to the development of post-smolt. Lerøy Midt states that there is a race to be the best farmer to optimize the rotation and the development of post-smolt. When it comes down to the last cent, the farmers are competitors, and hence, do not share their information. As presented in the industry analysis the situation for the growth of aquaculture in Norway is quite critical. If the farmers succeed with the development of post-smolt, it has the potential to create environmental benefits as well as benefits regarding production cost. When it comes to post-smolt, the farmers in Region Midt are keeping the cards close to their chests. TTK suggest that it is because they want to be first with a new solution. TTK argue that farmers will not be able to sustain a competitive advantage by keeping it a secret as other farmers soon will get hold of the solution. As there exist problems in the industry regarding keeping up the rate of innovation and technology development, it is believed by the researcher that the industry would benefit from being more open in the process of developing post-smolt.

Furter, TTK states that the larger firms carry out internal R&D to be able to lead the industry in the right direction. As Lerøy Midt states, they are not always possible to get hold of the solutions needed, and hence, they have to develop internally. De Marchi and Grandinetti (2013) draw attention to green innovators relying more on external R&D rather than internal. The complexity of green innovations implies the importance of combining different fields of expertise. Despite the risk for knowledge spillovers, firms should open up their business model and cooperate both vertically and horizontally when it comes to green innovations. By investing in relationships, firms can create a competitive advantage. To be able to cooperate regarding complex problem solving is believed to be key to increase the rate of innovation when it comes to green innovations. The findings in this thesis suggest that through cooperation, the problem with double externalities will decrease as the costs are shared among the partners. Moreover, being sustainable is important for the next generations. It is a responsibility of firms operating today, to take care of the resources so that the future generations have the same opportunities. Cooperating and sharing resources and knowledge is of crucial importance to reach the UN Sustainable Development Goals. Additionally, since future regulations are seen as an uncertainty and risk for firms, it is important that the government lead a transparent and predictable policy. To enable this, the communication between policy makers and industry is important. In line with Porter and van der Linde (1995), it is suggested that firms establish relationships with regulators to create a shared green vision.

Additionally, by operating in an open environment it is important to maintain the cognitive distance between firms and not let solidarity take over. The complexity of green innovation requires broad knowledge, and the researcher agrees with Ghisetti et al. (2015) that it is difficult for firms to satisfy the required knowledge by only using internal resources. Since internal R&D investments has no impact on green innovations Galia et al. (2015), it suggested that firm take advantage of opening up their business model to draw on external ideas.

The culture of sharing and trust in the Norwegian salmon farming industry is unique,

and has taken generations to develop. However, with today's speed of change and technological development, it is believed that firms in other industries can be inspired by this model, and implement it to better succeed with green innovation processes.

5.3 Implication for Managers

This study investigates how firms are using green innovation to create competitive advantage. The discussion implies that green innovative firms are firms that have acknowledged the importance of using resources efficiently. As green innovations are complex, it is argued that cooperation to establish a green shared vision will be important to be able to cope with environmental challenges. Managers need to facilitate the possibility for employees to engage in problems related to environmental concerns to establish a sense of urgency and, thus, understand the importance of sustainable development. Both case-firms have sustainability implemented in their strategy. This seems to be an important factor in getting the message out to all employees and to establish a shared vision across firm units. Hence, it is important that managers incorporate sustainability into their strategies to establish green values within the firm boundaries. Regarding sharing green values with partners and suppliers, it will be important that managers facilitate external knowledge sharing through interaction and engage all parts in an innovation process at an early stage. Managers also need to rethink their use of safeguards in relations. It is recommended that managers prioritize self-enforcing safeguards rather than third-party enforcement's to create more effective governance structures. Due to uncertainty and risk regarding future regulations, it is recommended that managers take a proactive role in establishing relationships between firms and regulators to enhance the communication with the parties as suggested by Porter and Van der Linde (1995)¹⁰. Based on the suggestions by Fernando et al. (2016), it is recommended that this can be done by developing shared labs and workshops to facilitate knowledge sharing. The goal of the collaboration is to create a green technology infrastructure. As a result, it will raise the level of expertise in the industry as well as in the regulators. Moreover, this can result in more transparency from the regulator's side. Operating in an open environment, it will be of crucial importance for firms to be able to assimilate information, and decide what is important for the firm and what is not. To increase the firms absorptive capacity, managers should prioritize diversity in the expertise of their employees. Having a diversity will broaden the perspectives of the firm, making it able to recognize the value of new knowledge.

5.4 Limitations

In this section limitations to using the Norwegian aquaculture industry to generalize findings related to green innovation will be discussed. The Norwegian aquaculture industry is seen as unique. Hence, the culture of the industry might make it hard to generalize the findings of this study. The regulations that have characterized the industry historically has been successful. Hence, regulations are central when studying the industry. This can be a limitation when generalizing the research green innovative firms. It is important to be

¹⁰This is presented in section 2.2.2 in Chapter 2

aware of this when considering the findings. Moreover, there may be constraints with regards to the geographical generalizability, and findings may not be valid in other countries with different market conditions. This study discusses the value chain, and to some extent the size of the firm, but it does not consider firm characteristics in detail when discussing green innovations. Thus, findings may diverge when studying firms of other characteristics.

5.5 Further Research

As this study suggests to favor incremental innovations when it comes to green innovation, it would be interesting to see further research either acknowledge or disprove this theory. Moreover, ambidextrous organizations have not been a discussion in this thesis. It could be interesting to see how green innovative firms should prioritize between exploration and exploitation to enhance firm performance. By studying ambidextrous organizations further research can look into the effect of exploration and exploitation on optimizing cognitive distance. In this thesis the research focus is on the individual firm level. It might be interesting for further research to study the Norwegian aquaculture as a lead market and how green innovations create competitive advantage in that matter. Additionally, the absorptive capacity of the firm and individuals will decide the firm's ability to explore new knowledge and exploit existing knowledge (Cohen and Levinthal, 2000). Moreover, regulations might have an impact on firms' willingness to use green innovations to differentiate themselves. It seems like they are more focused on using resources more efficiently to lower production costs and thereby creating competitive advantage. Hence, it would be interesting with further research on the relation between regulation and differentiation strategies. Regarding the double externality problem, it is believed that regulations have had a positive effect on reducing these and that the open and sharing culture has indeed made it easier for firms to be positive towards spillover effects. Also, as non-controllable variables easily affect all the farmers in the region, the spillovers are easily traced back to the firm producing them. Thus, further research on spillovers in the diffusion phase and how an open environment can decrease the negative effect of these spillovers for firms that implement green innovations would be interesting.

Conclusion

To answer the first research question¹ it is evident that this depends on the firm's strategy of differentiation or low cost. The findings of this thesis show that firms focusing on low cost use green innovation to come up with solutions that exploit resources more efficiently, and, hence, decrease production costs. Moreover, it is important to underline that, though it does not answer the research question directly, none of the case firms in this study emphasize regulations as the main driver for green innovation. Instead, both firms stress the environmental challenges and the importance for the aquaculture industry to take a proactive lead in sustainable development. It is observed that through external knowledge sharing firm can overcome the complexities of green innovation by drawing on ideas from internal and external resources. To succeed with external knowledge sharing, especially tacit knowledge, it is suggested that firms use self-enforcing safeguards such as trust and value sharing. Further, it is suggested that firms invest in incremental green innovations in cooperation with suppliers. Sharing knowledge in an incremental innovation process will limit the risk and uncertainty of not succeeding in green innovation processes. Thus, to answer the second research question², external knowledge sharing will help decrease the complexity of green innovations, as well as removing some of the risk and uncertainties related to whether or not the green innovation will be a success.

¹RQ1: How do firms use green innovation as a strategic tool to create competitive advantage?

²RQ2: In what way does external knowledge sharing contribute to green innovation processes?

Bibliography

- Abdullah, M., Zailani, S., Iranmanesh, M., Jayaraman, K., 2016. Barriers to green innovation initiatives among manufacturers: the malaysian case. *Review of Managerial Science* 10 (4), 683–709.
- Adams, M. E., Day, G. S., Dougherty, D., 1998. Enhancing new product development performance: an organizational learning perspective. *Journal of Product innovation management* 15 (5), 403–422.
- Aguilera-Caracuel, J., Ortiz-de Mandojana, N., 2013. Green innovation and financial performance: An institutional approach. *Organization & Environment* 26 (4), 365–385.
- Argote, L., Ingram, P., 2000. Knowledge transfer: A basis for competitive advantage in firms. *Organizational behavior and human decision processes* 82 (1), 150–169.
- Asche, F., 2008. Farming the sea. *Marine Resource Economics* 23 (4), 527–547.
- Asche, F., Bjørndal, T., Sissener, E. H., 2003. Relative productivity development in salmon aquaculture. *Marine Resource Economics* 18 (2), 205–210.
- Asche, F., Guttormsen, A. G., Tveterås, R., 1999. Environmental problems, productivity and innovations in norwegian salmon aquaculture. *Aquaculture Economics & Management* 3 (1), 19–29.
- Asche, F., Roll, K. H., Sandvold, H. N., Sørvig, A., Zhang, D., 2013. Salmon aquaculture: Larger companies and increased production. *Aquaculture Economics & Management* 17 (3), 322–339.
- Asche, F., Roll, K. H., Tveterås, R., 2009. Economic inefficiency and environmental impact: An application to aquaculture production. *Journal of Environmental Economics and Management* 58 (1), 93–105.
- Bar, E. S., 2015. A case study of obstacles and enablers for green innovation within the fish processing equipment industry. *Journal Of Cleaner Production* 90, 234–243.

-
- Barney, J. B., 1986. Organizational culture: can it be a source of sustained competitive advantage? *Academy of management review* 11 (3), 656–665.
- Bartlett, D., Trifilova, A., 2010. Green technology and eco-innovation: Seven case-studies from a russian manufacturing context. *Journal of Manufacturing Technology Management* 21 (8), 910–929.
- Beise, M., Rennings, K., 2005. Lead markets and regulation: a framework for analyzing the international diffusion of environmental innovations. *Ecological economics* 52 (1), 5–17.
- Berge, A., October 2014a. Pionérene: Brødrene vik. <https://ilaks.no/pionerene-brodrene-vik/>.
- Berge, A., October 2014b. Pionérene: Ove og sivert grøntvedt. <https://ilaks.no/pionerene-ove-og-sivert-grontvedt/>.
- Bogers, M., 2011. The open innovation paradox: knowledge sharing and protection in r&d collaborations. *European Journal of Innovation Management* 14 (1), 93–117.
- Bryman, A., 2016. *Social research methods*. Oxford university press.
- Chen, Y.-S., 2008. The driver of green innovation and green image—green core competence. *Journal of business ethics* 81 (3), 531–543.
- Chen, Y.-S., Chang, C.-H., Wu, F.-S., 2012. Origins of green innovations: the differences between proactive and reactive green innovations. *Management Decision* 50 (3), 368–398.
- Chesbrough, H., 2003. The logic of open innovation: managing intellectual property. *California Management Review* 45 (3), 33–58.
- Chesbrough, H., 2004. Managing open innovation. *Research-Technology Management* 47 (1), 23–26.
- Chesbrough, H., 2012. Open innovation: Where we've been and where we're going. *Research-Technology Management* 55 (4), 20–27.
- Cleff, T., Rennings, K., 2000. Determinants of environmental product and process innovation—evidence from the Mannheim Innovation Panel and a follow-up telephone survey. In: *Innovation-Oriented Environmental Regulation*. Springer, pp. 331–347.
- Cohen, W. M., Levinthal, D. A., 2000. Absorptive capacity: A new perspective on learning and innovation. In: *Strategic Learning in a Knowledge economy*. Elsevier, pp. 39–67.
- Dangelico, R. M., Pujari, D., 2010. Mainstreaming green product innovation: Why and how companies integrate environmental sustainability. *Journal of business ethics* 95 (3), 471–486.
- De Marchi, V., Grandinetti, R., 2013. Knowledge strategies for environmental innovations: the case of italian manufacturing firms. *Journal of Knowledge Management* 17 (4), 569–582.

-
- Dewar, R. D., Dutton, J. E., 1986. The adoption of radical and incremental innovations: An empirical analysis. *Management science* 32 (11), 1422–1433.
- Doz, Y. L., 1996. The evolution of cooperation in strategic alliances: Initial conditions or learning processes? *Strategic management journal* 17 (S1), 55–83.
- Dyer, J. H., 1997. Effective interfirm collaboration: how firms minimize transaction costs and maximize transaction value. *Strategic management journal*, 535–556.
- Dyer, J. H., Singh, H., 1998. The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of management review* 23 (4), 660–679.
- Dyer, W. G., Wilkins, A. L., 1991. Better stories, not better constructs, to generate better theory: A rejoinder to Eisenhardt. *Academy of management review* 16 (3), 613–619.
- Eisenhardt, K. M., 1989. Building theories from case study research. *Academy of management review* 14 (4), 532–550.
- Elkington, J., 2002. The triple bottom line.
- Ettlie, J. E., Bridges, W. P., O’keefe, R. D., 1984. Organization strategy and structural differences for radical versus incremental innovation. *Management science* 30 (6), 682–695.
- Fernando, Y., Wah, W. X., Shaharudin, M. S., 2016. Does a firm’s innovation category matter in practising eco-innovation? evidence from the lens of Malaysia companies practicing green technology. *Journal of Manufacturing Technology Management* 27 (2), 208–233.
- Fiskeridirektoratet, 2015a. Laks på land. <https://www.regjeringen.no/contentassets/1e8b96928110400eb0d5892b9c8c4bdb/laks-pa-land.pdf>.
- Fiskeridirektoratet, 2015b. Utviklingstillatelser. <https://www.fiskeridir.no/Akvakultur/Tildeling-og-tillatelser/Saertillatelser/Utviklingstillatelser>.
- Fiskeridirektoratet, 2016. Grønne tillatelser. <https://www.fiskeridir.no/Akvakultur/Tildeling-og-tillatelser/Kommersiell-tillatelser/Laks-oerret-og-regnbueoerret/Groenne-tillatelser>.
- Forseth, T., Finstad, B., Thorstad, E. B., 2012. Lakselus og effekter på vill laksefisk—fra individuell respons til bestandseffekter.
- Galia, F., Ingham, M., Pekovic, S., 2015. Incentives for green innovations in French manufacturing firms. *International Journal of Technology Management & Sustainable Development* 14 (1), 3–15.

-
- Ghisetti, C., Marzucchi, A., Montresor, S., 2015. The open eco-innovation mode. an empirical investigation of eleven european countries. *Research Policy* 44 (5), 1080–1093.
- Gibbert, M., Ruigrok, W., Wicki, B., 2008. What passes as a rigorous case study? *Strategic management journal* 29 (13), 1465–1474.
- Global Innovation Index, 2016. *Winning with global innovation*. Johnson Cornell University, INSEAD, WIPO.
- Guttormsen, A. G., 2008. Faustmann in the sea: optimal rotation in aquaculture. *Marine Resource Economics* 23 (4), 401–410.
- Hart, S. L., 1995. A natural-resource-based view of the firm. *Academy of management review* 20 (4), 986–1014.
- Hollensen, S., 2008. *Essentials of global marketing*. Pearson Education.
- Inkpen, A. C., Tsang, E. W., 2005. Social capital, networks, and knowledge transfer. *Academy of management review* 30 (1), 146–165.
- Jacobsen, D. I., 2016. *Hvordan gjennomføre undersøkelser?* CAPPELEN DAMM.
- Jaffe, A. B., Palmer, K., 1997. Environmental regulation and innovation: a panel data study. *Review of economics and statistics* 79 (4), 610–619.
- Jakobsen, S., Clausen, T. H., 2016. Innovating for a greener future: the direct and indirect effects of firms' environmental objectives on the innovation process. *Journal of Cleaner Production* 128, 131–141.
- Keizer, J. A., Halman, J. I., 2007. Diagnosing risk in radical innovation projects. *Research-Technology Management* 50 (5), 30–36.
- Kemp, R., Pearson, P., 2007. *Final report mei project about measuring eco-innovation*.
- Klewitz, J., Hansen, E. G., 2014. Sustainability-oriented innovation of smes: a systematic review. *Journal of Cleaner Production* 65, 57–75.
- Kvale, S., Brinkmann, S., 2017. *Det kvalitative forskningsintervju*. Gyldendal Norsk Forlag.
- Lavie, D., 2006. The competitive advantage of interconnected firms: An extension of the resource-based view. *Academy of management review* 31 (3), 638–658.
- Li, T., Calantone, R. J., 1998. The impact of market knowledge competence on new product advantage: conceptualization and empirical examination. *The Journal of Marketing*, 13–29.
- Lichtenthaler, U., 2011. Open innovation: Past research, current debates, and future directions. *The Academy of Management Perspectives* 25 (1), 75–93.
- Lin, H., Zeng, S., Ma, H., Qi, G., Tam, V. W., 2014. Can political capital drive corporate green innovation? lessons from china. *Journal of cleaner production* 64, 63–72.

-
- Lovdata, 2005. Akvakulturloven. <https://lovdata.no/dokument/NL/lov/2005-06-17-79>.
- Marine Harvest, 2017. Salmon farming industry handbook. <http://hugin.info/209/R/2103281/797821.pdf>.
- Marine Institute Foras na Mara, n.a. Salmon life cycle. <https://www.marine.ie/Home/site-area/areas-activity/fisheries-ecosystems/salmon-life-cycle>.
- Mattilsynet, 2014. Lakselusrapport: Høsten og året 2014. https://www.mattilsynet.no/fisk_og_akvakultur/fiskehelse/fiske_og_skjellsykdommer/lakselus/mattilsynets_lakselusrapport_desember_2014.17452/binary/Mattilsynets%20lakselusrapport%20desember%202014.
- Nofima, n.d. Optimalisert postsmoltproduksjon (opp). <https://nofima.no/prosjekt/optimalisert-postsmoltproduksjon-opp/>.
- Nonaka, I., 2000. A dynamic theory of organizational knowledge creation. In: Knowledge, groupware and the internet. Elsevier, pp. 3–42.
- Norsk Industri, 2016. Veikart for norsk havbruksnæring. <https://www.norskindustri.no/siteassets/dokumenter/rapporter-og-brosjyrer/veikart-for-havbruksnaringen---kortversjon.pdf>.
- Noteboom, B., 2002. Trust. Edward Elgar Publishing Limited.
- OECD, Eurostat, 2005. Oslo manual. Paris and Luxembourg: OECD/Eurostat.
- Oglend, A., Tvetas, R., 2009. Spatial diversification in norwegian aquaculture. *Aquaculture Economics & Management* 13 (2), 94–111.
- Olafsen, T., Winther, U., Mariussen, Å., Aslesen, H. W., Ørstavik, F., 2002. Innovasjonssystemet i norsk havbruksnæring.
- Olafsen, T., Winther, U., Olsen, Y., Skjermo, J., 2012. Verdiskapning basert på produktive hav i 2050. https://www.sintef.no/globalassets/upload/fiskeri_og_havbruk/publikasjoner/verdiskapning-basert-pa-produktive-hav-i-2050.pdf.
- Polanyi, M., 1966. The logic of tacit inference. *Philosophy* 41 (155), 1–18.
- Porter, M. E., 1986. Changing patterns of international competition. *California management review* 28 (2), 9–40.
- Porter, M. E., Kramer, M. R., et al., 2011. The big idea: Creating shared value.
- Porter, M. E., Millar, V. E., 1985. How information gives you competitive advantage.
- Porter, M. E., Van der Linde, C., 1995. Toward a new conception of the environment-competitiveness relationship. *Journal of economic perspectives* 9 (4), 97–118.

-
- PwC, 2017. Sustainable growth towards 2050. https://www.pwc.no/no/publikasjoner/shipping/PwC-Seafood%20Barometer.Web_V01.pdf.
- Quinn, J. B., 1992. *Intelligent Enterprise: A Knowledge and Service Based Paradigm for Industr.* Simon and Schuster.
- Ramsden, N., March 2016. Norway's salmon farmers spent over nok 5bn on sea lice treatments in 2015. <https://www.undercurrentnews.com/2016/03/02/norwegian-salmon-farmers-spend-over-nok-5bn-on-sea-lice-treatments-in-2015/>.
- Redclift, M., 2005. Sustainable development (1987–2005): an oxymoron comes of age. *Sustainable development* 13 (4), 212–227.
- Regjeringen, 2014. Forutsigbar og miljømessig bærekraftig vekst i norsk lakse- og ørretoppdrett. <https://www.regjeringen.no/contentassets/6d27616f18af458aa930f4db9492f5e5/no/pdfs/stm201420150016000dddpdfs.pdf>.
- Rennings, K., 2000. Redefining innovation—eco-innovation research and the contribution from ecological economics. *Ecological economics* 32 (2), 319–332.
- Rotvold, F., Suhr, E., 2016. What makes firms implement and succeed in green innovation?
- Schiederig, T., Tietze, F., Herstatt, C., 2012. Green innovation in technology and innovation management—an exploratory literature review. *R&d Management* 42 (2), 180–192.
- Seafood Norway, 2017a. Havbruk 2030. https://sjomatnorge.no/wp-content/uploads/2014/04/Havbruk-2030_final_EN.pdf.pdf.
- Seafood Norway, 2017b. Nurturing growth: the norwegian way. https://sjomatnorge.no/wp-content/uploads/2014/04/SFN_Aquaculture_DontPrint.pdf.
- Stien, A., Jansen, P. A., Kristoffersen, A. B., Viljugrein, H., Jimenez, D., Aldrin, M., 2012. Sea lice as a density-dependent constraint to salmonid.
- Taranger, G. L., Karlsen, Ø., Bannister, R. J., Glover, K. A., Husa, V., Karlsbakk, E., Kvamme, B. O., Boxaspen, K. K., Bjørn, P. A., Finstad, B., et al., 2014. Risk assessment of the environmental impact of norwegian atlantic salmon farming. *ICES Journal of Marine Science* 72 (3), 997–1021.
- Teece, D. J., 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research policy* 15 (6), 285–305.
- Teece, D. J., 1998. Capturing value from knowledge assets: The new economy, markets for know-how, and intangible assets. *California management review* 40 (3), 55–79.
- Thodesen, J., Grisdale-Helland, B., Helland, S. J., Gjerde, B., 1999. Feed intake, growth and feed utilization of offspring from wild and selected atlantic salmon (*salmo salar*). *Aquaculture* 180 (3-4), 237–246.

-
- Torrissen, O., Olsen, R. E., Toresen, R., Hemre, G. I., Tacon, A. G., Asche, F., Hardy, R. W., Lall, S., 2011. Atlantic salmon (*salmo salar*): the “super-chicken” of the sea? *Reviews in Fisheries Science* 19 (3), 257–278.
- UN, 1992. United nations conference on environment and development (unced): The earth summit.
- UN, 2015. Sustainable development goals. <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>.
- WCED, 1987. Our common future: Report of the world commission on environment and development.
- Webster, J., Watson, R. T., 2002. Analyzing the past to prepare for the future: Writing a literature review. *MIS quarterly*, xiii–xxiii.
- Williamson, O. E., 1989. Transaction cost economics. *Handbook of industrial organization* 1, 135–182.
- Wong, S. K. S., 2013. Environmental requirements, knowledge sharing and green innovation: empirical evidence from the electronics industry in china. *Business Strategy and the Environment* 22 (5), 321–338.
- Yin, R. K., 2009. *Case Study Research, Design & Methods* 4th ed.
- Yin, R. K., 2017. *Case study research and applications: Design and methods*. Sage publications.

Appendix

Appendix A



Figure 6.1: Wordcloud from interview with Måsøval



Figure 6.2: Wordcloud from interview with Lerøy Midt

Appendix B

Author(s)	Title	Journal	Research Focus	Methodology	Main Findings
Abdullah et al. (2015)	<i>Barriers to green innovation initiatives among manufacturers: the Malaysian case</i>	Journal of Management Science	Investigate the internal and external barriers to green innovation among Malaysian manufacturers.	Empirical. Survey of 153 manufacturing companies in Malaysia. Five different industries chosen by growth rate.	Barriers to product, process and system innovations are identified. Product: environmental resources, attitude and perception, business practices, government support, customer demand. Process: attitude and perception, business practices, poor external partnerships, insufficient information, lack of customer demand, environmental commercial benefits. System: environmental resources, attitude and perception, business practices, technical barriers, government support, environmental and commercial benefits.
Aguilera-Caracul and Ortiz-de-Mandojana (2013)	<i>Green innovation and financial performance: An institutional approach</i>	Journal of Organization and Environment	Compare green innovative firms and non-green innovative firms to determine in which national contexts green innovative firms tend to locate themselves. Analyse whether green innovative firms experience a higher improvement of their financial performance than non-green innovative firms.	Empirical. Green innovative firms selected based on amount of patents. 70 green innovative firms and 70 non-green innovative firms (matched pairs).	Intensity of green innovation is positively related to firm profitability. The stringency of a country's environmental regulations negatively moderates the relationship between green innovation and firm financial performance. No significant correlation between green innovation and firm performance. Did not find that green innovative firms experience a higher improvement of their financial performance than non-green innovative firms. Green innovative firms that exhibit a high level of green innovation intensity are able to enhance their corporate financial performance. The study suggests that top management commitment and support is essential for the development and implementation of green innovation
Amores-Salvadó, Castro and Navas-López (2014)	<i>Green corporate image: moderating the connection between environmental product innovation and firm performance.</i>	Journal of Cleaner Production	Natural resource based view is used to study how firms that develop environmentally proactive strategies achieve better performance.	Empirical. 157 Spanish firms. 21.3% rr.	Important with efficient management of the green image of the firm. Although firms may engage in communicative practices and strategies as a response to institutional pressures, the research shows that communicative efforts are a source of positive business results.
Antonioli, Borghesi and Mazzanti (2016)	<i>Are regional systems greening the economy? Local spillovers, green innovations and firms' economic performances</i>	Economics of Innovation and New Technology	EI's drivers and effects on firms' performance are investigated.	Empirical. Firm-level survey on manufacturing firms with more than 20 employees in the Emilia-Romagna region in the period 2006–2008.	Find that some firms' productivity performances are positively related to environmental innovation (EI) adoption. Firms that share the municipality location with EI adopters tend to have a higher likelihood of adopting EIs. Findings suggest that EIs can be a key source of growth for regional systems, particularly when spurred by local spillovers, and an important escape from the ongoing crisis.
Arnold and Hockerts (2011)	<i>The Greening Dutchman: Philips' Process of Green Flagging to Drive Sustainable Innovations</i>	Business Strategy and the Environment	Develop the concept of 'green flagging' as a groundbreaking corporate sustainability innovation strategy.	Qualitative. Longitudinal design. Empirical analysis of Philips, 29 persons interviewed from may 2004 til august 2009.	Argues that ecopreneurs can act as a pull factor by demonstrating the economic benefits of being greener. This pushes other firms to go green proactively in contrast to the push factors of government regulations, and stakeholder or lobby group pressure. Distinguishes between four different dimensions of change to explain factors of success or failure for the emergence and development of green innovations; design issues, user dimension, product service perspectives and the role of governance.

Chang (2011)	<i>The Influence of Corporate Environmental Ethics on Competitive Advantage: The Mediation Role of Green Innovation</i>	Journal of Business Ethics	Explores the positive effect of corporate environmental ethics on competitive advantage in the Taiwanese manufacturing industry via the mediator: green innovation performance. Divides green innovation in product and process innovation.	Empirical, Structural Equation Modeling (SEM): data from manufacturing companies in Taiwan. 106 valid questionnaires (21.2% rr).	Corporate environmental ethics positively affects green product innovation and green process innovation. Green product innovation mediates the positive relationship between corporate environmental ethics and competitive advantage, but green process innovation does not. Green process innovation is regarded as a low-cost strategy.
Chang and Chen (2013)	<i>Green Organizational Identity and Green Innovation</i>	Management Decision	Explore the positive effect of green organizational identity on green innovation performance. Wants to verify that environmental commitment and environmental organizational legitimacy mediate between the two.	Empirical. Questionnaire and public data hybrid method. Taiwanese manufacturing industry. 138 valid questionnaires.	Green commitment is significantly less in SMEs than in large enterprises. Green organizational identity affects green innovation performance directly and indirectly through environmental commitment and environmental organizational commitment.
Chen (2008)	<i>The Driver of Green Innovation and Green Image - Green Core Competencies</i>	Journal of Business Ethics	Proposes a novel construct - green core competence - to explore its positive effects on green innovation and green images of firms.	Empirical. Taiwanese information and electronics companies. 136 valid questionnaires.	Green core competence has a positive effect on green product innovation performance, green process innovation performance and green images. Green product and process innovation performance is related to green image.
Chen, Chang and Lin (2014)	<i>The Determinants of Green Radical and Incremental Innovation Performance: Green Shared Vision, Green Absorptive Capacity and Green Organizational Ambidexterity</i>	Sustainability	Proposes a new concepts, green organizational ambidexterity, that integrates green exploration learning and green exploitation learning simultaneously. Studies the antecedents green shared vision and green absorptive capacity, and consequential green radical and green incremental innovation performance.	Empirical. Survey in Taiwanese electronics industry. 202 valid questionnaires, rr. 33.67%.	Green shared vision and green absorptive capacity positively relate to green organizational ambidexterity, green radical innovation performance and green incremental innovation performance.
Chen, Lai and Wen (2006)	<i>The influence of Green Innovation Performance on Corporate Advantage in Taiwan</i>	Journal of Business Ethics	Explores whether the performance of the green innovation brings a positive effect to the competitive advantage of businesses in Taiwan. Presents the concepts of green product innovation and green process innovation. The study focuses on finding the correct evaluation and	Empirical. Use of a questionnaire survey method focused on the companies in the information and electronics industries in Taiwan. The samples were randomly selected from the <2003 Business	The study shows positive correlation between the performance of green product/process innovation and competitive advantage. The consumer electronics industry scored highest on green product innovation, whereas electronics component industries and semiconductor industry scored highest on green process innovation.

			position for green innovation.	Directory of Taiwan» of Business Express Co., Ltd.	
Costantini and Mazzanti (2012)	<i>On the green and innovative side of trade competitiveness? The impact of environmental policies and innovation on EU exports</i>	Research Policy	Explore how the export competitiveness of the European Union has been affected by environmental regulation and innovation. Uses Porter hypothesis and the neo Schumpeterian conceptual framework of technological regimes applied to economical sectors.	Empirical. 14 exporting EU countries over the time period 1996-2007.	Innovation intensity shows positive and robust effects over export competitiveness across the whole technological ladder, with a stronger impact on higher technology sectors. Public policies and private innovation patterns both trigger higher efficiency in the production process through various complementary mechanisms.
Cuerva, Triguero-Cano and Córcoles (2014)	<i>Drivers of green and non-green innovation: empirical evidence in Low-Tech SMES</i>	Journal of Cleaner Production	Analyzes the factors influencing the adoption of green and broad innovations in SMEs in the food and beverage industry.	Empirical. Based on survey from 2010. 2493 Low-Tech spanish firms (green and non-green). 301 answered (12% rr)	Technological capabilities such as R&D and human capital foster the conventional innovation but not the green innovation. Implementation of quality management systems and differentiation explain only the adoption of green innovative activities. Firms that have positive quality concerns and decide to implement a standardized quality management have more stimuli than others SMEs to adopt green innovations. Significant relationship between the strategy of product differentiation and environmental innovation. Negative and no significant result between public support and green innovations.
Dai, Cantor and Montabon (2015)	<i>How Environmental Management Competitive Pressure Affects Focal Firm's Environmental Innovation Activities: A Green Supply Chain Perspective</i>	Journal of Business Logistics	Drawing on the Schumpeterian perspective, and examines how the perception of rival firms' green success influences a firm to pursue and produce environmental innovation through its green supply chain integration activities. Differentiates incremental and radical environmental innovation, and reveals three dimensions: internal, supplier, customer integration.	Empirical. Survey data from 230 US firms. 16% rr	Green supply chain integration has a significant positive impact on developing radical environmental innovation. International integration activities increase incremental and radical environmental innovation activities. The supply chain plays an important role in engaging firms in environmental management competition. In order for a firm to better respond to a competitor's success in the development of green products, the firm needs to move beyond strong internally oriented green product development process to externally oriented green product development process.
Dangelico and Pujari (2010)	<i>Mainstreaming Green Product Innovation: Why and How Companies Integrate Environmental Sustainability</i>	Journal of Business Ethics	Presents three key environmental dimensions of green product innovation; energy minimization, materials reduction and pollution prevention as identified through the life cycle phases of products. Discusses firms	Empirical. 12 case studies of manufacturing SMEs in Italy and Canada.	Several motivations drive companies to develop green products. Environmental regulations are constraints, but also offer opportunities for risk regulation, and preservation of revenue and reputation. Expectations of green market growth and increasing profits as well as the improvement of reputation and image are important drivers of green product development. Another motivation is ecological responsibility. Risks can be increased public scrutiny by stakeholders, customer behaviour in buying more expensive products, government subsidies may not be consequent, .

			motivations to develop green products.		
Fernando, Shaharudin and Wahid (2016)	<i>Eco-innovation practices: a case study of green furniture manufacturers in Indonesia</i>	Journal of Services and Operations Management	Provides insights on how eco-innovation best practices can be implemented and also provides guidance to management for finding a best business model to reduce operating costs while providing environmental green and healthy consequences to society.	Empirical. Case study of four green furniture manufacturing firms identified from the Indonesian SMEs directory.	Green network is an emerging driver that can contribute to eco-innovation practices. Regulation is one of the key-factors for eco-innovation. Market pull is also a key-factor. New factor of eco-innovation: green network. Green furniture manufacturing companies can improve performance and achieve better sustainability through green networks.
Fernando, Wah and Shaharudin (2016)	<i>Does a firm's innovation category matter in practicing eco-innovation? Evidence from the lens of Malaysian companies practising green technologies.</i>	Journal of Manufacturing Technology Management	Investigates different types of innovations and their effects on eco-innovation practices by firms practicing green technology in Malaysia. Four categories of innovation: ideas, production, infrastructure and consumption. Key-drivers of eco-innovation: regulation, technology, cross-functional coordination, supplier involvement and market focus.	Empirical. Postal and online surveys distributed to top management of green technology companies in Malaysia. 150 questionnaires distributed, whereof 95 were returned (62.3% rr).	Firms practicing green technology should engage in an information-sharing culture with key suppliers regarding the latest know-how and technological developments. Firms should engage employees, customers, suppliers and competitors through co-production. No differences existed on how companies conducted coordination, commitment and cross-functional leadership in the practice of eco-innovation across the four categories of innovation. Suggests that firms practicing green technology should work together with the Malaysian Government to promote those technologies and offer products that can be created from renewable or recyclable resources.
Foster and Green (2000)	<i>Greening the Innovation Process</i>	Business Strategy and the Environment	Reports the results of how green issues are influencing the process of R&D as a contributor to innovation.	Empirical. Case studies of 9 UK companies.	Sorts cases into three categories of green innovation: 1. Green performance is a key issue for the user and a main driver behind innovation projects. Radical or incremental improvements of existing products and technologies. 2. A new market is resulting from the green agenda. Radically new technologies may be exploited, but may also be new applications of existing technologies. 3. Green issues receive limited attention, a form of compliance check. Environmental impact of the product or service is linked to its main function. Supply companies with the capacity and will to innovate need to push green issues to the agenda of their dialogue with users in order to actively seek opportunities for progress.
Frey, Iraldo and Testa (2013)	<i>The determinants of innovation in green supply chains: evidence from an Italian sectoral study.</i>	R&D Management	In detail this study aims to investigate the distinctive features of innovation carried out by SMEs, providing services, product or technologies in the environmental field operating in the district of Milan.	Empirical. Descriptive analysis: Survey addressed to 700 enterprises. 480 answered to telephone interviews.	The investigated sectors of the green economy are characterised by considerable innovation capabilities, and there are several improvement opportunities in the interactions along their supply chain. Positive impact of the variables 'dimension' and 'level of internationalisation' on innovation capabilities. Cooperation with research centres and access to capital market are positively related with effective innovations.

Appendix C

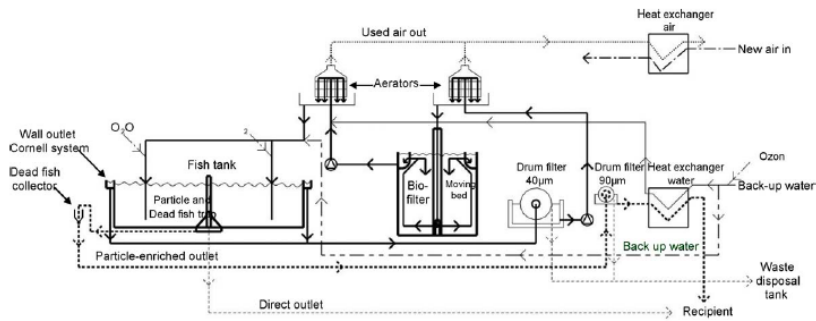


Figure 6.3: RAS

Appendix D

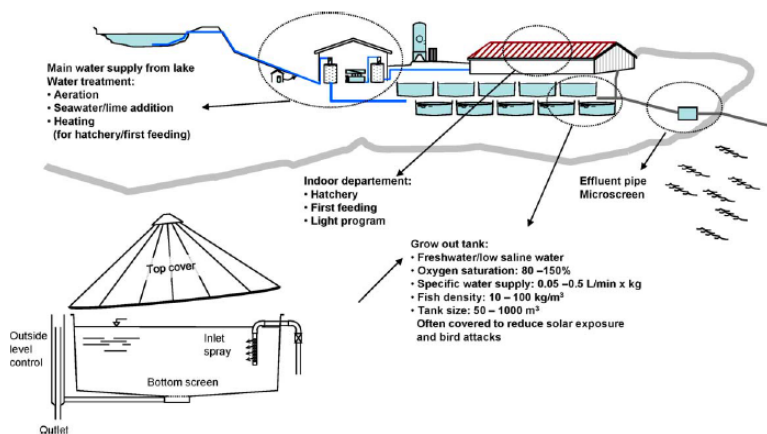


Figure 6.4: FT System

Appendix E



Appendix F

Intervjumal TTK

Intervjumal Rambøll

Hvilken stilling har du i Trøndersk kystkompetanse?

Hva er dine ansvarsområder?

Bakgrunn - Havbruksnæringen

Hva anser du som de største utfordringene næringen står ovenfor nå?

Hvordan jobber næringen for å få kontroll på disse?

Hvilke fortrinn har industrien i Norge fremfor andre nasjoner?

Har dere observert noen plutselige endringer i næringen?

Bærekraft

Hva ligger til grunn når man tenker “bærekraftig havbruk”?

Hvordan jobber næringen for å være bærekraftig?

Er det noen utfordringer knyttet til det å være bærekraftig?

Dukker det opp nye muligheter som resultat av bærekraftstrategien?

Hvordan fanges/utnyttes disse mulighetene?

Innovasjon

Hvem er det som er de største driverne for nye innovasjoner i næringen? Leverandører,

innovasjonsmiljøer, oppdrettere, kunder, reguleringer?

(Eks. Internt, eksternt, vekst, reguleringer etc.)

Hvordan jobber næringen med nye innovative løsninger?

Hva er de største utfordringene med innovasjonsprosesser?

Møter næringen på noen uforutsette utfordringer? eks. høye kostnader, langsiktige prosesser, høy risiko?

Reguleringer

Hva er deres syn på dagens reguleringer av havbruksnæringen?

Kunnskapsdeling

Hvordan jobber næringen mtp. deling av kunnskap og erfaringer? Åpent/lukket? Internt/eksternt?

Hvordan tar de i bruk disse kunnskapskildene?

Hvem deler aktørene erfaring med? Hvordan skjer kunnskapsdeling?

Kan du si noe om konkurransebildet i næringen? Vil du si det er preget av tett samarbeid mellom ulike aktører? Hva tror du dette kommer av?

Fasiliteres samarbeid av tredjepart eller er det av eget initiativ fra oppdrettere?

Vet du om aktørene vanligvis inngår partnerskap basert på formelle (finansielle, økonomiske incentiver) eller uformelle (tillit, omdømme) kontrakter?

Samarbeid med andre industrier, fagmiljøer? Hva karakteriserer disse fremfor andre samarbeid internt i miljøene?

Postsmolt

Hvilke faktorer ser dere på som kritisk viktige for å lykkes med produksjon av postsmolt?

Hva er fordelene med denne typen løsning fremfor andre mulige løsninger?

Hva er de største usikkerhetene/kunnskapshullene?

Hva er de største risikoene knyttet til et slikt prosjekt?

Fremtiden

Store fremtidige risikoer i næringen?

Digitalisering?

Hva tror du industrien kommer til å være preget av i fremtiden i form av nye teknologiske løsninger og politiske reguleringer?

Appendix G

Introdusere deg selv. Fortelle om masteren. Spør om du får lov til å ta opp samtalen. Er det noe de ønsker ikke skal presenteres i masteren? Informer om taushetsplikt med Rambøll.

Hvis noen av spørsmålene er litt uklare er det bare å gi beskjed til meg. Vi kommer til å starte med en liten sånn intro der jeg bare spør litt overordnet om deg og Måsøval. deretter tenker jeg vi kan prate litt løst rundt de neste spørsmålene der jeg håper vi får til mer en samtale fremfor et intervju :)

Intro

Hvilken stilling har du i ...?

Hva er din bakgrunn/utdannelse?

Hva er dine ansvarsområder?

Overordnet strategi

Hva er overordnede strategi for Måsøval? Hvem utvikler denne/bestemmer hva det skal satses på? Dukker det opp mange nye muligheter som resultat av bærekraftstrategien? Hvordan fanges disse opp/utnyttes disse?

Hva er Måsøval sin visjon og mål?

Hvordan vil du beskrive organisasjonsstrukturen?

Hvordan vil du beskrive organisasjonskulturen?

Ulike utdanningsnivåer?

Kulturforskjeller? Hvor kommer de ansatte fra?

Rom for å gjøre feil? Tillit? Kontroll?

Innovasjonsprosesser

Hvem er involvert i innovasjonsprosesser? Benytter dere spesielle rammeverk/prosesser/modeller for innovasjon? I hvilken grad har ansatte frihet til å jobbe med nye produkter/idéer? Hvordan fanger dere opp nye idéer til produkter? Hva er de største utfordringene dere opplever i innovasjonsprosesser?

Hvordan løser dere disse?

Hvilke innovasjonsprosesser er dere involvert i nå?

Reguleringer

Hvilken rolle spiller disse for valg av innovasjoner?

Hva er deres syn på dagens reguleringer av havbruksnæringen?

Får dere ekstern støtte til utvikling? Hvordan påvirker dette utviklingsprosessen?

Postsmolt

Hva var motivasjonen/driveren(e) bak beslutningen om å produsere postsmolt?

Hvilke eksterne og/eller interne faktorer skapte initiativet?

Hvor kom initiativet fra? f.eks ledelsen, enkeltperson etc. Var det spesielle personer/avdelinger som var pådriver for å utvikle postsmolt?

Hvilke personer var med i beslutningsprosessen?

Hvilke alternative investeringer ble vurdert?

Hvordan ble investerings- og driftskostnader og marginer vurdert i beslutningsgrunnlaget?

Hvilke målsetninger og forventninger har blitt satt for strategien?
Hvilke faktorer ser dere på som kritisk viktige for å lykkes med produksjon av postsmolt?
Er det noe som skiller dere fra andre aktører som fokuserer på postsmolt?

Med deres eksisterende kompetanse innen settefiskanlegg, hvordan bidro dette til beslutningen av postsmolt fremfor andre utviklingsprosjekter?
Hva er den største forskjellen med hvordan dere operer på mtp postsmolt i forhold til hvordan dere opererte før? Er det store endringer?

Samarbeidspartnere

Har dere noen viktige samarbeidspartnere når det kommer til utvikling av postsmolt? Hvem?
Hva vil du si kjennetegner dette samarbeidet? Er dere avhengig av denne partneren? Evt hvorfor?
Hvordan møtes dere?
Er samarbeidet basert på formelle (finansielle, økonomiske incentiver) eller uformelle (tillit, omdømme) kontrakter?
Hvilke utfordringer støter dere på? F.eks. hvordan tar dere beslutninger?
Samarbeider partneren med andre konkurrenter i næringen?

Kunnskap

Hvilke strategier har Måsøval mtp kunnskapsoverføring?
Hvilke utfordringer ser dere nå ved å overføre eksisterende kunnskap om settefisk til produksjon av postsmolt?
Hvordan løser dere eventuelt disse utfordringene?
Er det mange kunnskapshull i forbindelse med utvikling av postsmolt?
Hvordan dekkes disse kunnskapshullene?
Hvor søker dere etter kompetanse?
Hvilke arenaer og verktøy ser dere på viktige for å tilegne seg og dele kunnskap?
Hvordan mener du at næringens struktur påvirker kunnskapsdeling og - utvikling?

Utfordringer

Har dere møtt på noen uforutsette utfordringer i utviklingen av postsmolt? eks. høye kostnader, langsiktige prosesser, høy risiko?
Hvis dere skulle begynt prosessen på nytt, hva ville dere gjort annerledes?
Er det ressurser dere ikke har tilgang på i dag som dere gjerne skulle hatt?

Hva tror dere industrien kommer til å være preget av i fremtiden i form av nye teknologiske løsninger og politiske reguleringer?
