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Enabling sustainable growth in the Norwegian seafood industry

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How can the seafood cluster of Western Norway, with respect to its completeness and interactions, resolve the sustainable challenges in the industry through innovations?

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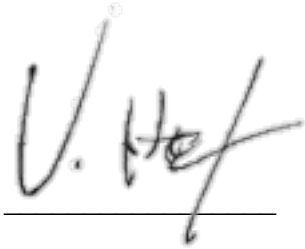
BI Norwegian Business School

Oslo, June 2017

Hedvig Binde



Veronika Hoff

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EXECUTIVE SUMMARY

This master thesis focuses on the seafood cluster of Western Norway, and analyzes how the cluster can resolve the environmental challenges in the industry through innovations. The industry is currently facing a turning point, where further growth can be feasible only if the environmental challenges in the industry, namely sea lice, fish escapes and area utilization, are resolved. The government has introduced means, in the form of development licenses, to incentivize the industry to realize new technological innovations. This created an exciting impetus for empirical application of theories – clustering, innovation and sustainability. The study contributes by exploring the intersections between the different theories.

The data collected for this thesis contain semi-structured interviews carried out with cluster member representatives that were knowledgeable about the industry and the innovations emerging from the cluster. In addition, a comprehensive selection of secondary data was collected to support the primary data. The authors applied the Emerald Model (Reve & Sasson, 2012) for the purpose of analyzing the cluster, and consider its completeness and knowledge interactions in relation to its capacity to innovate. Further, specific selected innovation projects were analyzed in terms of their nature and impact on the industry. Moreover, Porter and Linde's (1995) theory of a properly crafted environmental regulations were applied in the analysis of these projects, and their potential to resolve the sustainable issues of the industry. The innovation projects subject to the case study were "The Egg" (Marine Harvest and Hauge Aqua) and "Ocean Farm 1" (SalMar).

The research found that the chosen cluster obtains a complete value chain and to an extent strong knowledge relations and interactions, and hence possesses a high capacity to innovate. The authors regarded the innovations "The Egg" and "Ocean Farm 1" as sustaining radical innovations that may eliminate the environmental challenges, if successful. However, the realization of such projects hinges on the granting of development licenses, and thus the authors question whether the rest of the industry is able to adopt similar solutions. In addition, the authors believe that a technical solution is unlikely to solve these issues alone, but could prove successful in combination with a biological solution.

1.0 INTRODUCTION

For this master thesis the authors have chosen to examine the seafood cluster of Western Norway and recent innovations, brought forth by its cluster members, to assess whether the environmental issues in the industry can be overcome. By analyzing the seafood cluster of Western Norway, and its members situated within the cluster, the authors have carried out a case study to provide a holistic and in-depth research approach. The seafood cluster of Western Norway, of which includes the counties of Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal, and Sør-Trøndeland, is highly interesting as it contributed to nearly 50 percent of salmon production in Norway in 2016, includes many major globally competing players, and is in the center of biological and technological emergent innovations.

2016 was marked as a record year for Norwegian salmon aquaculture industry, but the value creation stemming from this relatively young industry has not necessarily been driven by productivity growth the past decade, but by high salmon prices, as the salmon production the past five years has in fact stagnated. Despite this, the aquaculture industry is special in the sense that it is one of the few industries where Norway possesses a globally leading position on know-how. Several governmental and intergovernmental organizations recognize the value of what is obtained from Norwegian fjords and the knowledge that is built up, and estimates the value creation from aquaculture to more than double within 2030. For this to occur, the industry has to address the factor inhibiting growth. Here, the Norwegian government acknowledges that growth can only be assumed if the environmental challenges of the industry are solved.

In the aquaculture context, the Norwegian government has recognized the main environmental challenges to be sea lice, fish escape, and area utilization. As a result of stagnating growth and increased focus on sustainability, the government has introduced means, or development licenses, to incentivize the industry to realize new technological solutions, which can help solve the environmental issues the industry is facing. Emerging innovations have hence boomed out of the seafood cluster of Western Norway. This context provides an interesting foundation for the authors aim to analyze the cluster concept, innovations and sustainability, and hence propose the following research question for the paper:

How can the seafood cluster of Western Norway, with respect to its completeness and interactions, resolve the sustainable challenges in the industry through innovations?

The authors decided to refine the thesis according to the cluster concept's geographical notion and include only those industry actors situated within the cluster, being the counties of Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal, and Sør-Trøndeland, with activities related to salmon farming. In addition, the innovations examined include those innovations placed in sea that replaces and supplements the traditional farming solutions of the industry.

The master thesis is based on an overview of relevant literature concerning clustering, innovations and sustainability, both separately and coincided. Based on the findings of the literature explored, the authors developed interview guides that were applied in multiple in-depth interviews with cluster members, ranging from government representatives, research institutes, universities, technological suppliers and farming companies. The results and findings of these interviews in addition to secondary data collection in the form of public documents and statistics provided the foundation to analyze the scope of the research question.

The authors aim to contribute to theory by exploring the intersections between clusters, innovations and sustainability. Although much literature has explored the concepts in isolation, the authors believe that this thesis is of high relevance as it highlights the concepts coincidently in the exciting industrial context of the seafood cluster of Western Norway.

2.0 THEORETICAL FOUNDATION

The research problem of this thesis is threefold, and the theoretical foundation will hence present and discuss the literature supporting both the causal variables (clustering and innovation) and the outcome variable (sustainability). The authors will start by discussing cluster theory. Here, Michael Porter's Diamond Model and Torger Reve and Amir Sasson's Emerald Model will be discussed as they account for a large part of the thesis analysis. Further, innovation and its context in the cluster theory will be discussed. Lastly, sustainability will be presented and discussed, as this will be a factor included in the discussion part of this thesis.

2.1 The Cluster Concept

The origin of the cluster concept dates back to Alfred Marshall's publication of 'Principles of Economics' in 1890, and of what now is known as 'Marshallian industrial districts'. Marshall focused on the regional agglomerations of capabilities that enabled nations to emerge as industrial nations, and argued "regional concentration encouraged vertical specialization, which in turn eased firm entry into a particular specialty, thus resulting in high levels of horizontal competition. Firms could be owned and managed by the same people; there was no need to invest in the types of managerial organization that by the late nineteenth century were becoming central to the growth of firms in the United States, Germany, and Japan. In the industrial districts, economies of scale were external, rather than internal to the firm." (Fagerberg, Mowery & Nelson, 2006).

Even though the cluster concept was introduced in the nineteenth century, it was not heavily research until the 1990s. Michael Porter is widely credited with popularizing the cluster concept in 'Competitive Advantages of Nations' (1990). He defines clusters as "geographic concentrations of interconnected companies and institutions in a particular field" (Porter, 1998, p. 78), and sees clusters as including:

- "Linked industries and other entities, such as suppliers of specialized inputs, machinery services, and specialized infrastructure
- Distribution channels and customers, manufacturers of complementary products, and companies related by skills, technologies, or common inputs
- Related institutions such as research organizations, universities, standard-setting organizations, training entities, and others." (Cortright, 2006, p. 3).

According to Porter (2008) clusters can affect competition in three ways: (1) increasing the productivity of cluster members; (2) increasing capacity for innovation and productivity growth; and (3) replicate new business formation that can carry the innovation and grow the cluster. In this way, a cluster can be described as a system of organizations and institutions whose value as a whole is greater than the sum of it.

Many have presented their own variations of the clustering concept, where Rosenfeld (2002, p. 10) defines a cluster as "a spatially limited critical mass (that is sufficient to attract specialized services, resources, and suppliers) of companies

that have some systemic relationships to one another based on complementarities or similarities."

Considering the economic and technological implication of clusters, there are two views in which clusters can affect national, state and regional growth. Some cluster theorists have emphasized the external and industrial resource conditions, and argue that superior industrial resources and social networks that gives access to 'cutting-edge information' is the key to cluster growth. Alternatively, cluster theorists have emphasized the internal and technological dynamisms (Zhang et al., 2009). The latter view resulted from Saxenian's (1994) observations of the Silicon Valley region that outperformed other clusters based on their flexible and technological dynamisms that promoted collective learning for several firms. This master thesis will focus on the technological dynamisms view on cluster, in accordance with the attributes of the selected cluster.

2.1.1 The Diamond Model

In "The Competitive Advantage of Nations" (1990), Michael Porter claims that a nation's competitiveness depends on its ability to innovate and upgrade, and argues that the attributes of the industrial environment are the foundation to succeed in given industries. Superior factor conditions, sophisticated demand conditions, internationally competitive related and supporting industries and appropriate firm structure, strategy and rivalry are the groups of factors contributing to cluster competitiveness (Porter, 1990).

Factor conditions, most particularly labor, land, natural resources, capital and infrastructure, should be of high standard. Sophisticated and advanced industries have realized that factor conditions are not necessarily inherited, but created – such as specialized education and research institutions linked to the given industry. The most important factor conditions are those that involve sustained and heavy investment and are specialized (Porter, 2008).

Although increased globalization allows industries to meet the demand of customers worldwide, *demand conditions* in the home market are important. More important than the size is the nature of the home market. If companies are subject to customers with sophisticated demand, the companies are able to obtain a richer overview of emerging needs, and are pressured to innovate faster and achieve more sophisticated advantages than their foreign rivals (Porter, 2008).

Internationally and competitive *related and supporting industries* within geographic proximity of the industry facilitates great advantages across the value chain, especially in terms of innovation and upgrading. The companies benefit when suppliers are globally competitive due to cost-effective inputs at the lowest possible transaction costs, and when related industries exchange information which in turn speed the rate of innovation (Porter, 2008).

Lastly, *firm strategy, structure and rivalry* concern the context in which companies are created, organized, and managed, as well as what the nature of the domestic rivalry. Additionally, the presence of strong local rivals creates pressure to increase productivity and technological innovation, unlike the Five Forces model that favors low rivalry (Porter, 1990).

Porter emphasize that the more developed the conditions of the diamond model is, the greater the productivity of the firms in the industry. Also, the model should be viewed as a system, as the performance of one condition influences the other conditions, as well as reinforce each other (Porter, 2008).

2.1.2 The Emerald Model

Reve and Sasson (2012) extended the role of clusters and competitiveness when undertaking a study of Norwegian clusters. The authors introduced the term *global knowledge hubs* for knowledge-intensive clusters, and developed the Emerald Model (Reve & Sasson, 2015).

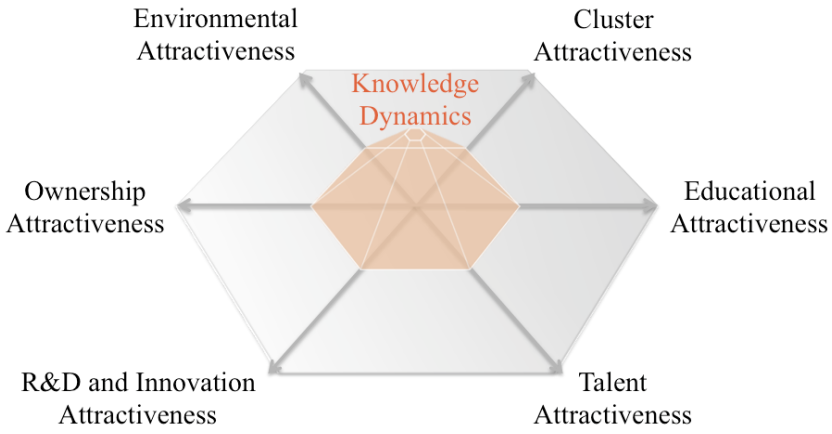
Attractive industrial clusters in advanced economies are increasingly becoming more knowledge-based and global, and this applies not only to the so-called high-tech locations, but also high-cost locations, such as Norway (Reve & Sasson, 2012). The authors argue that there is an emergence of increasing concentration of knowledge-based firms at locations that is connected to a specific industry. The most known examples are Silicon Valley's role within IT, Basel's role in pharmaceuticals, and Boston's role within biotechnology (Reve & Sasson, 2012). These industrial developments, or *super clusters*, have such appeal that the key enterprises in the industry simply must be located there. The authors further put forth the term *global knowledge hub*.

Global knowledge hubs include the innovation- and knowledge-related driving forces in the industry, and hold a unique combination of the most advanced knowledgeable companies that is at the forefront of research and development and the most qualified owners. The concept of global knowledge

hubs is not primarily locational bundles of firm's headquarters, but industrial clusters where a majority of the major global players have located their "centers of expertise" (Reve & Sasson, 2012).

The question regarding whether an industry can be regarded as a global knowledge hub is two-folded, and according to Reve and Sasson (2012) one first has to consider whether the industry meets the requirements in terms of the knowledge and ownership attractiveness, and then whether the industry has the necessary knowledge dynamics, has to be determined empirically. The authors hence developed the Emerald Model, which is a metric of seven dimensions for determining cluster attractiveness. The first six dimensions of 1) cluster attractiveness; 2) educational attractiveness; 3) talent attractiveness; 4) R&D and innovation attractiveness; 5) ownership attractiveness, and; 6) environmental attractiveness, applies to the first part of the Emerald Model, being the requirements of knowledge and ownership attractiveness. The last and seventh dimension, knowledge dynamics, considers the second part of the Emerald Model and is the main variable when looking at the links between the actors in the clusters.

Figure 1: The Emerald Model



Source: Adapted from Reve & Sasson, 2012

Degree of *cluster attractiveness* determines whether an industry in a certain nation or region holds a critical mass of firms that make it possible to define the industry as an industry cluster. According to Reve and Sasson (2012) industrial clusters holds a horizontal structure, with several competing firms at the same level in the industry, and a vertical structure, with firms at different levels in the value chain. The cluster attractiveness is measured through the size of the industry (e.g. number of firms, value creation, and employment), industrial

breadth and depth, degree of internationalization, and diversity of goals to capture different technologies, business models and related activities (Reve & Sasson, 2012).

Educational attractiveness captures educational opportunities giving access to qualified labor for the industry. The focus here is not on the general education system, but if there are any attractive educational programs that provide specialized labor to the industry. Truly outstanding global knowledge hubs are also the educational centers that attract talent from around the world (Reve & Sasson, 2012). Take for example the biotechnology cluster of Boston that are closely collaborating with Massachusetts Institute of Technology (MIT) on developing different programs and courses in order to educate a specialized workforce.

Talent attractiveness explains to what degree the industry is able to attract the best-qualified labor force from various specialized backgrounds. A knowledgeable and specialized industry in growth is expected to take an increasing share of available qualified labor, and Reve and Sasson (2012) argue that an increasing share of the labor in such industries have higher education. Another dimension of talent attractiveness captures to what degree the labor force in the industry have international background, as the leading global knowledge hubs attracts highly qualified labor force worldwide.

R&D and innovation attractiveness captures the proportion of research and innovation activities happening in the industry relative to the size of the industry. Industries that are global knowledge hubs also represents the research and innovation centers in the worlds, which can be measured with different targets of volume, concentration and quality, both on the input and result side (Reve & Sasson, 2012).

Ownership attractiveness is measured by looking at the ownership structure of a given industry. An attractive industry attracts various types of ownership capital, from early risk capital, stock capital, private equity, family ownership, industrial ownership, financial ownership and foundation ownership, as well as what percentages poses at private, public and foreign ownership. Reve and Sasson (2012) views no objections in terms of private, public or foreign ownership, hence ownership competition and –diversity is thus positive concepts in which both impel industrial development. Competent ownership will improve

capital allocation between investment projects and consequently encourage good industrial development (Reve & Sasson, 2012).

Environmental attractiveness captures whether the industry is able to meet future environmental and climate requirements, and if it looks at environment as a profitable area for technology development and new business opportunities. Many industries view the environmental aspect very differently, from CO_2 emissions to environmental friendly buildings. Reve and Sasson (2012) argue that environmental attractiveness can be measured by estimating a change in environmental profile, for example increased CO_2 emissions.

The six dimensions of the emerald model gives the foundation of the industrial attractiveness (knowledge pool) of a cluster, but the value and total attractiveness has to be considered in the context of *knowledge dynamics,* being the links, connections or synergies between players in the industry and players in other and related industries (Reve & Sasson, 2012).

2.2 Innovation

Much confusion exists regarding the proper definition of innovation, widely caused by scholars' narrow focus on either level of analysis (individual, group, firm, industry, consumer, region, nation) or the type of innovation (product, process, and business model) (Crossan & Apaydin, 2009). The global marketplace is increasingly characterized by social, economic, and technological changes, and innovation eases the process of adaptation to many of these (Gopalakrishnan & Damanpour, 1997). In business studies, it has become collectively and widely accepted that innovation is regarded as a vital source of competitive advantage in increasingly changing environments (Tushman & O'Reilly, 1996; Dess & Picken, 200; Piperopoulos, 2012).

Various dimensions of innovations can be categorized into two directions: those relating to innovation as a process, that is "the process of introducing something new", and those relating to innovation as a discrete product or outcome defined as "a new idea, method or device" (Gopalakrishnan & Damanpour, 1997, p. 16). For the purpose of this thesis the authors will view innovation as an outcome, wherein innovation literature regards most innovations as sustaining and entailing improvements to existing products and services. In relation to the Norwegian seafood industry, innovations tend to be regarded as either

technological, biological or commercial innovations. The authors wish to focus solely on technological innovations when analyzing emerging innovation projects.

Theory has further considered innovations according to the "newness" or degree of change, wherein concepts such as radical, incremental, sustaining and disruptive often emerges (Christensen, 1997; Hill & Rothearmel, 2003; Yu & Hang, 2010). The authors wish to emphasize the degree and impact of innovations for the purpose of this thesis, wherein the concepts of radical versus incremental innovations and disruptive versus sustaining innovations will be presented in the next section.

2.2.1 Types of Innovation

Types of innovations has traditionally been distinguished according to two extremes, and viewed on a dichotomous scale, but tend to use different terminologies; (1) revolutionary, discontinuous, breakthrough, radical, emergent or step-function innovations; (2) evolutionary, continuous and incremental innovations (Yu & Hang, 2010). By regarding these two extremes as radical and incremental innovations, researchers define *radical innovations* as profound changes in the activities of a firm or an industry that signify a clear parting from existing practices, and *incremental innovations* as marginal changes that reinforce the existing capabilities of the firm that signify a minimal departure from existing practices (Gopalakrishnan & Damanpour, 1997). According to Hill and Rothaermel (2003) incremental innovations build solely upon the established knowledge base of the incumbent as it gradually improves the practices and materials of the firm. On the other hand, radical innovations include practices and materials that are novel to the incumbent, as a consequence of either different knowledge base or recombination of the firm's current knowledge base with a new stream of knowledge. To integrate this new knowledge, the firm must have absorptive capacity and must be able to develop new capabilities (Cohen & Levinthal, 1990).

Some brief examples to clarify these two concepts. First, the arrival of sensor technology in aquaculture represents an incremental innovation, where it is used for surveillance to detect escapes, diseases, plant damage, oxygen levels, nutrients, feed consumption, currents, etc. (Morland, 2017). Second, the arrival of land based farming facilities represents a radical innovation, where it is used from the coast of Denmark to the desert in Israel. It is radical because it departs from

the traditional practices of utilizing the sea to this not being a dependent factor, and it removes the competitive advantages that countries with coastlines possess (Plast Forum, 2014).

While differentiating innovation according to two extremes along one dimension helps clarifying the types of innovation, it does not tell the whole story. Based on a series of previous technological innovation studies and the anomalies of the different terminologies of the two extremes, Clayton Christensen (1997) developed disruptive innovation theory. Christensen's "The Innovator's Dilemma" (1997) gave birth to the term *disruptive technology*, which was later renamed to *disruptive innovation* in Christensen and Raynor's "The Innovator's Solution" (2003). The innovator's dilemma can briefly be described as follows; the reason "why great companies fail" is that good management itself does everything by the book. Decision-making and resources-allocation is, among others, based on listening to customers, tracking competitors, investing to build higher performance and higher quality products that yield greater profit. These processes that traditionally are the key to success of incumbent companies are the same processes that rejects disruptive technologies. The management hence gets blindsided by an innovation that rapidly takes away its markets, because it was doing everything by the book (Christensen, 1997). The management hence faces the innovator's dilemma: "should we invest to protect the least profitable end of our business, so that we can retain our least loyal, most price-sensitive customers? Or should we invest to strengthen our position in the most profitable tiers of our business, with customers who reward us with premium prices for better products?" (Christensen & Raynor, 2003, p. 39) With the introduction of disruptive innovation theory, Christensen classified innovations as either *sustaining* or *disruptive*.

The concepts of sustaining and disruptive innovations are very different from the incremental and radical innovation scale, as disruptive innovation theory view disruption as a market/business phenomenon that has little to do with technology per se. However, a *sustaining innovation* targets demanding, high-end consumers with better performance than what was previously available – some are incremental and some are radical. Regardless of technological difficulty, the established competitors almost always win the battles of sustaining technology, as the strategy entails making a better product the company can sell for a higher premium. *Disruptive innovations*, on the other hand, does not entail producing

better products to existing markets, but rather redefine that demeanor by introducing products that are not as good as currently available products. They are, however, simpler, more convenient, and less expensive that appeals to new or less-demanding customers. When this disruptive product gains traction in the new or low-end market, and the technological improvement evolves, the not-good-enough technology eventually improves enough to intersect with the needs of more demanding customers, and the disruptor are on a path that will ultimately crush the incumbents (Christensen & Raynor, 2003).

The key is that the two-folded scales of *radical-vs-incremental* and *disruptive-vs-sustaining* views innovation from different angles. The radical-vs-incremental innovation scale considers the innovation's magnitude of change and the capabilities implicated– incremental if low, and radical if high - and has much to do with the specific innovation or technology (Gopalakrishnan & Damanpour, 1997; Hill & Rothaermel, 2003; Christensen & Raynor, 2003). The disruptive-vs-sustaining innovation scale is, in contrast, a market/business phenomenon and has little to do with the specific innovation. Hence, an incremental innovation can be either sustaining or disruptive, and a radical innovation can also be either sustaining or disruptive – these are not concepts that are predetermined based on the categorization of the other (Christensen & Raynor, 2003).

2.2.2 Clusters and Innovations

Innovation is increasingly viewed as a collective action that involves a diverse group of actors that exchange and combine their knowledge. Much recent work focuses on how clusters and networks enhance collaboration and innovation (Letaifa & Rabeau, 2013). Here, Porter and his associates are prominent. Porter (1990) emphasizes how innovation contributes to a location's competitive advantage. The most distinctive causes of innovation that affect competitive advantage are (1) new technologies; (2) shifting buyer needs; (3) emergence of a new industry segment; (4) shifting availability, and; (5) changes in government regulations (Porter, 1990). According to Roelandt and Hertog (1999) alliances of firms, interaction and exchanges among organizations, research institutes, universities, and other institutions, are at the core of the innovation process. Innovation is hence a dynamic social process that evolves most successfully in a network in which intensive interaction takes place between those 'producing' and those 'using'.

The advantages that cluster participation brings forth in innovation compared to doing innovation in isolation are many. First and foremost, cluster members are able to more clearly and rapidly perceive new buyer needs, as a result from the different buyer knowledge relationships among the cluster members (Porter, 2000). Second, cluster members can be exposed to greater insights of new technological, operating and delivery possibilities though the linkages and relationships within the cluster, through for example direct observation of other cluster members (Porter, 2008). Third, firms within a cluster are able to more rapidly source new components, machinery and other elements necessary to implement innovations through for example local suppliers that also take part in the cluster (Porter, 2008). Then there is the advantage of lower transaction costs due to the geographic proximity and relationships among the organizations of the cluster. Facilitation of these advantages is the competitive environment and peer pressure, and constant comparison occurring among the cluster members. Similarity of microeconomic industrial environment and circumstances combined with the existence of several rivals, forces cluster members to distinguish themselves, creating a fruitful avenue for innovation (Porter, 2008).

2.2.3 Innovation Dynamics of Clusters

While most research focus on why clusters facilitate for innovation, fewer have focused on the dynamics in which innovation happens within clusters. Traditionally contributors have pinned down three basic endogenous upgrading mechanisms characterizing dynamic regional clusters, namely (1) complementarity, (2) innovation pressure, and (3) knowledge dissemination (Reve & Jakobsen, 2001).

The first mechanism, *complementarity,* emphasize the presence of similar firms ranging from specialized subcontractors and service firms to education and research facilities specialized to the given industry. Here, innovation processes may speed up as a result of diverse knowledge and proximity to each other. The second upgrading mechanism, *innovation pressure*, originates from Porter (1990), and occurs when it exist local demanding customers and several producers competing, which further results in the need to innovate. The last upgrading mechanism, called *knowledge dissemination*, emphasize development and diffusion of knowledge inside the cluster. New knowledge spreads fast within

regional clusters when processes of sharing and copying are successful, which in turn develops innovations further (Isaksen, 2009). According to Frenken et al. (2007), the upgrading mechanisms require that the cluster firms have common features in terms of product, technology or markets.

More recent research put great importance on the concept of 'innovation systems' in underpinning the innovation dynamics of clusters. The concept of innovation systems argues that innovations do not emerge in isolation within one firm, but stems from interaction by a number of entities, actors and agents (Lundvall, 2010). In addition to the cluster concept, innovation systems, or more notably regional innovation systems (RIS), also belong to the geographical agglomeration theory category. Even though these two concepts are closely related, they should not be mixed together. Whereas the cluster concepts focuses on specialized 'interdependent' firms of the same industrial sectors within a geographical area, a RIS, on the other hand, focuses on knowledge generation and exploitation systems linked to global, national and other regional systems. From this follows that clusters and RIS often co-exist in the same geographical area (Asheim & Coenen, 2005).

2.3 Sustainability

Due to the nature of the research question, sustainability becomes an outcome in the later presented analysis and must therefore be addressed and theoretically defined. The following section will constitute of a brief definition of the term followed by some relevant theory for our further analysis.

The term sustainability has been defined numerous times, and is often seen as somewhat vague. One of the most used definitions of sustainable development was coined by the World Commission (1987, p. 16) in their report "Our common future", which defined it as "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The overall term, sustainability was then divided into three pillars; social, environmental and economical. These may coincide and one may be realized as a result of a change in another. Social sustainability entails the just distribution of resources among the people of the world. It considers the inequalities in the world, and focuses on the social well-being of people with a focus on the reduction of poverty, social injustice and promoting peace. Environmental sustainability considers the whole ecosystem and sources of renewable resources that does not

harm the earth. Finally, economic sustainability concerns advocating economic growth whilst sustaining reasonable consumption levels (FN, 2017).

Despite the term being structured into three pillars, economical sustainability has often trumped social and environmental in many countries leaving especially the environment in an unhealthy state. Nevertheless, Norway is a highly developed country, both in terms of the social and economic aspect, and hence in recent years much focus has been on the environment and creating sustainable solutions for the future. However, as part of the explanation behind the stagnation of growth in the seafood industry is the sea lice issue, one can clearly see that environmental issues impede the economic growth, hence economic and environmental sustainability coincide. The authors therefore wish to shed a light on environmental sustainability and its importance in the seafood industry of Western Norway, whilst keeping in mind the interconnectedness with economic sustainability.

2.3.1 Environmental Sustainability

Global warming has received a lot of attention the past decade where most of the blame lies on the Northern hemisphere and the greenhouse gas emissions stemming from the population's overconsumption. In developing countries, issues such as drought, flooding and other natural disasters have a major impact. In addition, the pressure on nature threatens the biological diversity, leading to extinction of several species. For centuries, the world has been reliant on resources such as gas, oil and coal, however at some point these will run out, thus we must invest in renewable resources such as wind, forest and water to meet our high consumption levels (FN, 2016).

In 2015 the UN created 17 goals for sustainable development towards 2030, which included several environmental concerns such as climate change, clean energy and marine resources. Certain goals, such as Goal 14 'Life under water', and Goal 12 'Responsible consumption and production', apply especially to the chosen research setting, as Norway is considered an ocean nation and is the world's sixth largest fish exporting nation. Within these goals one can find targets which include; significantly reducing marine pollution, ending overfishing, conserving 10 per cent of coastal and marine areas, and efficient use of natural resources. These goals are not legally binding, but the UN encourages and expects

governments to take ownership and establish their own frameworks to reach these goals (UN, 2015).

In 2009, the government released its 'Strategy for an environmentally sustainable Norwegian aquaculture Industry', where it presented the issues regarding escaped fish, pollution and emissions, sea lice and diseases, area utilization, and feed resources as the factors inhibiting sustainable growth in the industry (Regjeringen, 2009). In the more recently published Ocean Strategy of 2017, the government put emphasis on goal 14 from the UN sustainable development goals and the factors of sea lice, escaped fish, and area utilization as the most pressing issues in the industry (Regjeringen, 2017: b). These three issues are also consistent with the perceptions of the cluster members situated within the seafood cluster of Western Norway.

Therefore, as there seem to be an apparent understanding amongst the players in the industry, the authors wish to continue on this path and name these three issues; sea lice, escaped fish and area utilization, as the pressing sustainability challenges of the seafood industry in Norway. These issues are somewhat interrelated, as a positive turn in one issue could decrease or eliminate another issue. It should be mentioned that feed has also become an increasing concern within the industry, as sourcing ingredients (such as soya) is not sustainable. The authors do not wish to pursue this issue however, as the solution to this may be biological rather than technological, which is the main interest in this thesis. These three emphasized issues will be thoroughly explored in later sections of this thesis.

2.3.2 Policy Making

Traditionally, the relationship between environmental goals and industrial competitiveness has been viewed as a tradeoff between social benefits and private costs. Porter and Linde (1995) disagree with this static debate and points to theory regarding dynamic competitiveness, which suggests that properly designed environmental regulations can trigger innovations that offset the cost of complying with these regulations. In such ways, firms can essentially benefit from environmental regulations. Porter and Linde draws on six purposes that properly crafted environmental regulations can serve. These include: regulation informs companies regarding possible resource inefficiencies; regulation focused on information gathering may achieve benefits by raising corporate awareness;

regulation reduces the uncertainty that environmental investments will be valuable; regulation create pressure that motivates innovation and progress; regulation levels the playing field; and lastly; regulation is needed in the case of incomplete offsets.

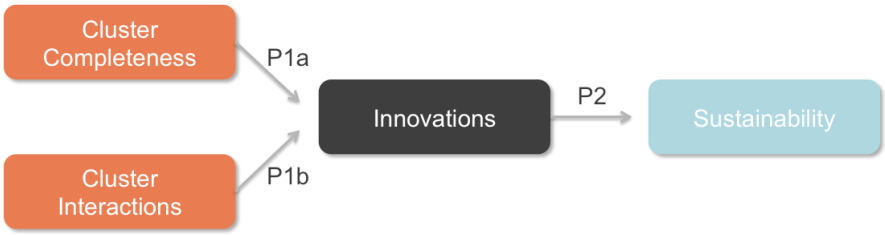
Authors such as Hazilla and Kopp (1990) and Gray (1984) have a different view, however, and largely focus on the costs assuming no innovation, i.e. no benefits. Jorgenson and Wilcoxen (1990) have also left the benefits out of the equation, creating solely a negative outlook on the view of environmental regulation. There are obviously examples where innovation does not occur, and if it does occur, the costs of that innovation might exceed the gains. However, the question that prevails is; would these types of innovations emerge if no pressure to change existed? Throughout Porter and Linde's article (1995), the authors exemplify cases where regulations on pollution, CO_2 and water purification have led to significant innovations allowing for economic gain and increased market share. It ultimately comes down to the policy makers creating this 'properly crafted environmental regulation', and that the companies see the opportunities in these regulations. In the research setting, the government has granted aquaculture licenses (needed to carry out fish farming) to specific companies which have committed themselves to comply with very strict environmental regulations such as reducing escape and sea lice contamination (Fiskeridirektoratet, 2014). The most recent announced license (development license) will be granted to companies, which can develop new and innovative technology that can solve one or more of these above-mentioned issues (Fiskeridirektoratet, 2016: a). Despite extremely high investment costs to develop these new innovations, this is an opportunity for companies to think outside the box, with the backing of the government, which could potentially be very meaningful for the future of fish farming.

The increased attention towards sustainability has put pressure on policymakers to introduce new regulations and for the companies to comply with these changes. Examples from Porter and Linde point to benefits from complying with environmental regulations and taking an active part in becoming sustainable. The article goes as far as to say that these pressures, which trigger innovations, may ultimately lead to competitiveness. This thus provides an interesting background for our further research on this thesis.

2.4 Conceptual Framework

Existing literature have repeatedly acknowledged the relation and dynamics between clusters and innovations. In addition, literature has attempted to recognize the connection between innovations and sustainability. There does not, however, seem to be sufficient literatures that explore these relationships and intersections jointly. The authors hence aim to explore these relationships in the context of the seafood cluster of Western Norway, and thus lay forth the following conceptual framework with accompanying propositions:

Figure 2: Conceptual framework



2.4.1 Proposition 1

The conceptual variables of cluster completeness and cluster interactions can be both considered interchangeably and separated based primarily on Reve and Sasson's (2012) Emerald Model. *Cluster completeness* will be considered according to the first six of the seven dimensions of the Emerald Model, which gives the foundation to consider whether the cluster attain the appropriate completeness in terms of resources, knowledge and expertise across the value chain to be regarded as a global knowledge hub. *Cluster interactions* will be considered according to the seventh, and last, dimension of the Emerald model, namely knowledge dynamics. According to the model's creators, strong knowledge dynamics of a cluster appears through interactions, collaboration and synergies among the parties within the cluster.

The overall attractiveness and competitiveness of the cluster has to be considered through analysis of all the seven dimensions of the Emerald interchangeably. Cluster completeness (or complete value chains) is a dimension of cluster strength, which in itself is the foundation of the cluster's competitiveness. It is through cluster interactions (knowledge relations) in the cluster that this foundation is utilized, and hence global competitiveness is created, in the form of increased capacity for innovation and productivity. Both

Reve and Sasson (2012) and Porter (2008), recognizes the relation between competitive clusters and increased capacity for innovation. Thus, considering the seafood cluster of Western Norway the following is proposed:

P1 – Clusters hold a high capacity to innovate when obtaining a) complete value chain, and b) strong knowledge relations and interactions.

2.4.2 Proposition 2

Regarding the concept of *innovation*, literature has frequently connected the notion to activities entailing improvements and changes, and has recognized different degrees of this process, both in terms of newness, or technological difficulty, and market and business impact (Yu & Hang, 2010; Christensen & Raynor, 2003). The innovation that has emerged from the seafood cluster of Western Norway will hence be at the center of this thesis, where it will be analyzed both in terms of types of innovation, and its position in the cluster. Environmental *sustainability* is the outcome of a sustainable development that aims to protect and consider the whole ecosystem and its resources in order to benefit future needs (World Commissions, 1987). This term varies from industry to industry, but the Norwegian aquaculture industry has reached a common consensus of the environmental challenges to be regarded as sea lice, fish escapes and area utilization.

Traditionally, innovations targeting environmental goals have been a tradeoff between social benefits and private costs (Porter & Linde, 1995), but in the context of the seafood cluster of Western Norway, the Norwegian government has put forth environmental policies in the form of development licenses that facilitates for innovations targeting the environmental challenges of the industry. According to Porter and Linde (1995) properly designed environmental policies and regulations triggers discoveries and introduction of new and more environmental friendly improvements, which ultimately contributes to the industry's and the firm's long term competitiveness. Thus, considering the emerging innovation projects and the environmental sustainability within the seafood cluster of Western Norway, the following is proposed:

P2 – Environmental sustainability can be achieved through innovations triggered by governmental policies

3.0 RESEARCH METHODOLOGY

This section of the paper is devoted to the description of the appropriate methodology utilized in this thesis, as well as highlighting the flexibility of the qualitative method. Scholars draw a clear distinction between qualitative and quantitative research, and with regards to the proposed research question of this report, *How can the seafood cluster of Western Norway, with respect to its completeness and interactions, resolve the environmental challenges in the industry through innovations?* the overall characteristics of our research is deemed as a qualitative research. This is because the authors aimed to attain a deductive view of the relationship between theory and research, which can only be achieved through conceptualization. The qualitative research approach further allowed the authors to keep an open-ended research strategy (Bryman & Bell, 2015).

This section is further roughly based on assignments in GRA6836 Research Methodology for Strategy and GRA19502 Preliminary Master Thesis.

3.1 Research Design

The *research design* is an overall plan of how the authors attempt to answer the research question. It includes clear objectives, originated from the research question, denote a clear research strategy, and considers the inevitably constraints of the research (Saunders et al, 2009). A research design that is carefully thought-out and appropriately implemented will further enhance the reliability, replicability and validity of the research (Bryman & Bell, 2015).

The research question should be formulated according to the objective and purpose of the research, wherein the threefold of exploratory, explanatory and descriptive is commonly used (Yin, 2014). The objective of this master thesis is to study and establish a causal relationship between theoretical variables, in which a complete cluster with strong cluster interactions creates suitable conditions for innovation to happen, which in turn may have a positive effect on the sustainability aspect. Based on these characteristics, as well as the nature of the formulated research question, the authors consider this thesis to be an *explanatory* study. The authors aim to understand and analyze cluster completeness and interactions through the seven dimensions of Reve and Sasson's (2012) Emerald Model, then analyze the emerging innovations in the industry to, in the end,

consider whether these contribute to elevating the Norwegian aquaculture industry into becoming sustainable.

As the authors have focused on one single cluster, the research was carried out using the *case study design*. In this way, the chosen case, the seafood cluster of Western Norway, became the foundation of a thorough, holistic and in-depth research of the aspects that the authors wanted to explore. In general, this research design is suitable when authors aim to focus a study on extensively exploring and understanding, rather than confirming and quantifying (Kumar, 2011). Lastly, the case study design is suitable for this master thesis as it is flexible relative to different methods of data collection; in-depth interviews, information obtained from secondary data, observations and so on.

3.2 Sampling

Purposeful sampling in qualitative research deals with recognizing and selecting individuals that are knowledgeable and experienced with the specific topics and objects of interest (Palinkas et al., 2013). In this thesis, an expedient population is those firms and institutions directly linked to the aquaculture industry located within the selected area. The subgroup within this population that was found purposeful to interview is called the sample (Saunders et al., 2009).

The authors applied the *non-probability sampling technique* when sampling, meaning that the authors aimed to interview and talk to individuals that are knowledgeable about the industry in general, including its opportunities, challenges and environment, and recent innovations. A purposeful sampling in this master thesis was hence two-folded. First, the authors interviewed individuals that are knowledgeable about the seafood industry in general to obtain an overall understanding about how the industry works, its potential for growth, and problem areas. In this stage, the authors approached the NCE Seafood Innovation Cluster (Henceforth NCE SIC), the Ministry of Trade, Industry and Fisheries, Innovation Norway, SINTEF and University of Bergen. Second, when the authors needed to go more into depth and exploit theory, it was found appropriate to interview individuals that are knowledgeable about the innovations in the industry that are currently emerging. These interviews added and confirmed the overall view in the first interview phase. Here the authors conducted interviews with the companies that were managing own innovation projects, such as Lerøy Seafood Group, Hauge Aqua, and Ocean Farming AS.

The authors found, however, that the non-probability sampling technique relied heavily on mapping, access and contact with the appropriate candidates a priori data collection, which was especially difficult when establish contact on project-level. The authors hence decided to incorporate the *snowball sampling technique*. In this manner, the initial interview objects are able to recruit or refer to future possible interview objects that can be included in the sampling "portfolio" (Bryman & Bell, 2015). For example, Tanja Hoel (Managing Director, NCE Seafood Innovation Cluster) could refer and recommend other knowledgeable individuals within the cluster that would be of value for the authors. By applying the snowball sampling technique the authors were able to maintain a flexible sampling by opening up for interviews with cluster member introduced by our initial contacts.

Contact with NCE SIC in Bergen was established from prior thesis relation, whom early agreed to initiate contact on the author's behalf with relevant parties for this thesis. There are, however, several large industry-related companies and institutions that are left out due to the NCE SIC's organization's geographical appraisal centered in Bergen. This fact designates the weakness of the snowball sampling technique, as the authors was not put in contact with individuals or companies outside the geographical area of Hordaland.

To ensure a representative and heterogeneous sampling portfolio that covers the entire geographical scope of the chosen cluster, the authors applied the *purposive sampling technique* in addition to the snowball sampling technique. This allowed the authors to judge which companies that were suitable for sampling outside the geographic location of the NCE SIC, and add seafood companies located in the counties of Rogaland, Sogn og Fjordane, Møre og Romsdal and Sør-Trøndelag into the sampling portfolio. Examples here is SalMar and SINTEF Ocean located in Sør-Trøndelag. The authors took direct contact with the companies and interviews were conducted via telephone.

3.3 Data Collection

Data collection is the key point in the research where data is collected in order to answer the research question (Bryman & Bell, 2015). The data collection in this case is divided into primary and secondary data.

3.3.1 Primary Data

The choice of primary data collection method depends the research question and the nature of the topics of interest will be considered (Bryman & Bell, 2015). In accordance to the selected research design and strategy, the authors decided to conduct qualitative semi-structured interviews.

In *semi-structured interviews* the researcher is guided by a list of themes and questions that is to be covered while interviewing, highly recognized as an interview guide (Saunders et al., 2009). Conducting semi-structured interviews allowed the authors to stay flexible and cover a wide range of issues and motivations. Although semi-structured interviews grant high flexibility, it is crucial that the interviews are by large similar with regards to themes, topics and questions in order to obtain a comparable data collection (Bryman & Bell, 2015).

The authors tailored the semi-structured interviews for the different interview objects according the goal of the interview, the interviewees position in the cluster, e.g. whether the sample is positioned within a farming company, research institution, or educational institution and so on, and knowledge about topical questions.

First, Bjørn Arne Skogstad (Innovation Norway), Marius Dalen (Ministry of Trade, Industry and Fisheries), Tanja Hoel (NCE Seafood Innovation Cluster), Arne Fredheim (SINTEF Ocean), and Sigurd Stefansson (University of Bergen) was interviewed regarding the Norwegian aquaculture at whole in terms of performance, challenges, opportunities and the emerging innovations, and cluster development. The authors used this information to gain a clearer picture of the industry and the chosen cluster before interviewing others (**Exhibit 1**, Interview Guide #1). Further, the obtained information prepared the authors for the interviews and was valuable in terms of exploring linkages within the theory of cluster completeness and interactions. The interviews with the remaining individuals gave the authors deeper insight into the topics explored with the first interviewees, as well as information regarding specific innovation projects and perceptions on the future for Norwegian aquaculture (**Exhibit 1**, Interview Guide #2 & #3).

The interviews were carried out either face-to-face at different locations in Bergen and at the North Atlantic Seafood Forum, or by telephone call or Skype meeting. All the interviews were taped and transcribed, which made the authors able to listen to interviews several times and enhanced the data in terms of

citations and quotes. Each of the interview objects were informed regarding confidentiality, anonymity and participation in the thesis, and everyone agreed upon the collection. While this enhanced the primary data collection, it may have made the interview objects less willing to engage in controversial discussions.

Table 1: The Interview Objects

NAME	COMPANY	POSITION
Arne Fredheim	SINTEF Ocean	Research Director
Arvid Hammernes	Ocean Farming AS	Managing Director
Bjørn Arne Skogstad	Innovation Norway	Program Leader in NCE and GCE
Borghild Hillestad	SalmoBreed AS	Genetics Manager
Geir Atle Rød	Hauge Aqua AS	Business Development Director
Harald Sveier	Lerøy Seafood Group	Technical Manager
Ingunn Wergeland	Sealice Research Centre	Senior Advisor
Marius Dalen	Ministry of Trade, Industry and Fisheries	Senior Advisor
Rolf Solberg	Blue Farm AS	Chief Executive Officer
Rudi Ripman Seim	SalmoBreed AS	R&D and Technical Manager
Sigurd Stefansson	University of Bergen	Professor
Tanja Hoel	NCE Seafood Innovation Cluster	Managing Director

3.3.2 Secondary Data

In addition to semi-structured interviews, the authors relied on material collected by others. Secondary data sources were utilized to provide in-depth understanding of the case and as a complementary source to verify that our obtained data does not deviate exceedingly from prevailing knowledge (Saunders et al., 2009). The most important secondary data obtained was public and private documents gathered from among others the NCE SIC, Innovation Norway, other cluster organizations, governmental web portals and statistical databases. For the methodological and theoretical part of the literature, the authors used academic journals and books.

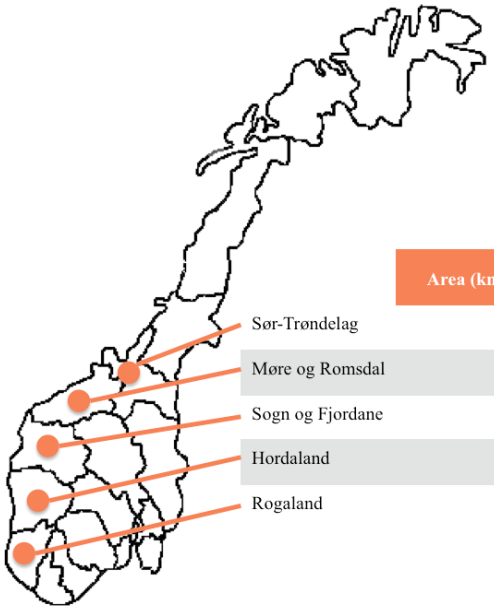
Secondary data sources bear numerous advantages such as cost- and time efficiency, high-quality data and "pre-analyzed" material (Bryman & Bell, 2015). Limitations are connected to data complexity, absence of key variables, and self-bias.

4.0 REGIONAL PROFILE OF WESTERN NORWAY

In order to be able to thoroughly consider the competitiveness of Western Norway, and to best describe the context within which the seafood cluster of Western Norway is elevating, the authors found it important to first acquire a macroeconomic overview of Norway as a nation, and second consider the industrial attributes of the chosen industrial environment by applying Porter's Diamond Model (1990).

Western Norway includes the counties of Rogaland, Hordaland, Sogn og Fjordane, and Møre og Romsdal. For the purpose of the clustering tendencies examined in this thesis, Sør-Trøndelag will henceforth be included as a part of Western Norway. Consequently, Western Norway accounts for 20.1% of Norway's land area, and 32%, or 1,055 million, of Norway's inhabitants (SSB, 2017: a).

Figure 3: Key figures Western Norway



	Area (km²)	Area (% of Norway in total)	Inhabitants	Inhabitants (% of Norway in total)
Sør-Trøndelag	18,848	4.89 %	250,382	4.77 %
Møre og Romsdal	15,121	3.93 %	188,712	3.59 %
Sogn og Fjordane	18,623	4.83 %	66,320	1.26 %
Hordaland	15,460	4.01 %	429,366	8.18 %
Rogaland	9,378	2.43 %	412,385	7.85 %

Source: SSB, 2017: b

4.1 Economic Performance

The economic performance of Norway reflects an environment economically robust, and is, according to World Economic Forum, regarded as an innovation-driven economy (WEF, 2015).

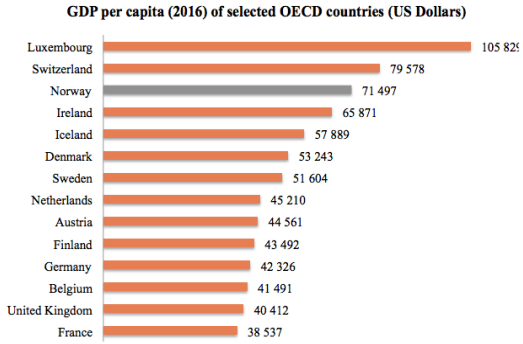
Throughout the 1950-70s, Norway had relatively low GDP per capita compared to the OCED average, and even more so compared to Denmark and Sweden. The economic features of the nation before the discovery of the oil and gas is characterized by a welfare state with reliance on manufacturing industries related to the long Norwegian coastline (Cappelen & Mjøset, 2009). Norway's economy has transformed since the discovery of oil and gas in the late 1960s, and is today among the wealthiest nations in the world (OECD, 2016: a). Norway's economy throughout the past decades has remained stable due to macroeconomic management of the oil prosperity via the sovereign wealth funds (the Norwegian and global Government Pension Fund) and the associated fiscal policies (OECD, 2016: a). In fact, World Economic Forum ranks Norway's macroeconomic environment as the best among the 138 countries in the survey.

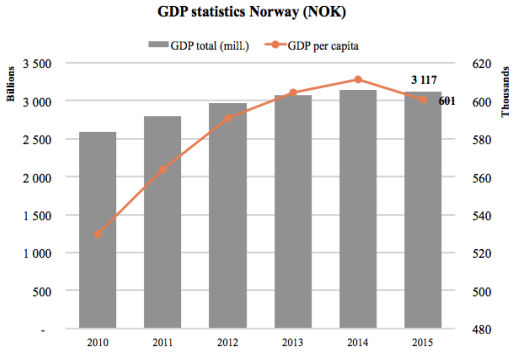
Recent macroeconomic developments feature a slowing economy mainly due to the large fall in oil prices in 2014, which has depressed oil-related activities. Economic ripple effects have been shown in the rate of unemployment in the petroleum related regions, which increased to about 4% in 2015. Still, low interest rates, housing wealth and the fiscal policy supports the consumption. In addition, exchange rate depreciation and slowed wage growth helps the national competitiveness. Lastly, decrease of exports of oil and gas related goods have trended a slight upwards in other Norwegian exporting industries due to the weak currency, especially in seafood (OECD, 2016: a). As a result, the drop in the oil-price has proven to be a reflection point where a flexible, competitive and productive Norwegian economy and floating exchange rate are crucial to mitigating external shocks and to develop balanced growth once the income from petroleum begins to diminish. Regardless of mitigating measures, the drop in Norway's primary industry has created concern relating to decline in productivity growth and international competitiveness.

As of 2016, Norway is ranked as the third nation with the highest gross domestic product per capita in the world, and among the OECD countries (Knoema, 2017). In 2015, the GDP was a total of 601,596 NOK per capita, while the total Norwegian GDP was at 3,177 BNOK. This is a decline from the previous

year GDP per capita and total GDP of approximately 1.75% and 0.75% respectively (SSB, 2017: c; d).

Figures 4 & 5: GDP Statistics





Source: Knoema, 2017; SSB, 2017: c; d

4.2 Western Norway's Competitiveness

The Diamond model of the selected region reflects an industrial environment with superior factor conditions, sophisticated demand conditions, international industries and a rich foundation for cluster development. Everything point to the region as a suitable foundation for cluster completeness and interactions. In the following section the authors will apply the diamond model to the seafood industry of Western Norway. A summary of the main findings is illustrated in **Exhibit 2**.

4.2.1 Factor Conditions

Rich natural resources, sound educational- and legal systems provide Western Norway with strong factor conditions. The only caution lies with the infrastructure.

Western Norway lies along the rich Norwegian coastline, providing countless islands, bays, fjords, valleys and rough climate, which lays the foundation of the various industries existing in the region (Bergen Næringsråd, 2017). However, these rich natural endowments do have a negative effect on infrastructure, which is the largest pitfall of the region's factor conditions. The fact that the region inhabits such traits in addition to a low population density prompts problems for logistics. Western Norway is further the home to five of Norway's ten largest harbors, of which Bergen is by far the largest, accounting for just under 29 percent of the freight transport on the coast in the last quarter of 2016 (SSB, 2017: e).

The educational level is equally distributed among the five counties. For people aged 25 and higher, an average of 44 percent holds a high school educational level, 25 percent holds a university or college bachelor degree, while 10 percent holds a masters degree (SSB, 2017: f). Rogaland, Hordaland and Sør-Trøndelag further hold a higher educational level than Sogn og Fjordane and Møre og Romsdal, which can be explained by the fact that these counties inhabits some of Norway's largest universities and colleges, such as University of Stavanger, University of Bergen and Norwegian School of Economics and Business Administration (NHH) in Bergen, and University of Norwegian University of Science and Technology (NTNU) in Trondheim (Regjeringen, 2017: a). The World Economic Forum's GCI Report ranks Norway high in terms of quality of higher education with a rank of 7 out of 138 countries; however, the report adds that Norway has low universities rankings compared to the neighboring countries (WEF, 2017).

With regards to the labor productivity, the wage levels in Norway do not greatly vary much from municipality to municipality, as Norway is an egalitarian society. However, somewhat higher wage levels can be seen in the population dense counties, wherein Rogaland, Hordaland and Sør-Trøndelag have a wage level above national average (SSB, 2017: g).

4.2.2 Demand Conditions

The nature of the home market of Western Norway reflects a market with high purchasing power and sophistication. The home market is, however, characterized by a small population and intense exporting.

With overall high wages, customers in Norway have high purchasing power. The average household net-adjusted disposable income per capita is 283,443 NOK, well above the OECD average of 246,300 (OECD, 2016: a). Further, on county level, Rogaland, Hordaland and Sør-Trøndelag stands out positively in terms of national average, while Møre og Romsdal ends up just below this average. Sogn og Fjordane's average household net-adjusted disposable income per capita, however, ends up well below national level. In fact, it is among the bottom two in Norway above Finnmark. Disregarding this, as Norway has an overall high disposable income, buyer sophistication has increased recent years, and people have become more conscious (WEF, 2017). With a population of only 5.3 million the domestic market in Norway is small, hence the

country is reliant on export, with more than 85% of its export going to the EU (SSB, 2017: h). Trade agreements such as EFTA and EEA hence becomes important for the industries in Western Norway, as it exist many manufacturing industries such as aquaculture and oil and gas (EFTA, 2017).

4.2.3 Related and supporting industries

The nature of the industries operating within Western Norway reflects an environment with various sized firms with a flat business structure, suitable for cooperation, innovation and foreign direct investments. The only caution lies with the local competitive landscape.

In the seafood cluster of Western Norway, most companies are regarded as small and medium sized enterprises with a flat business structure. In fact, more than 94,2 percent of all businesses in Western Norway have less than 20 employees, and less than 2 percent of all businesses have more than 50 employees (SSB, 2017: i).

Since 2002, the efforts of furthering Norwegian cluster development began to intensify when Innovation Norway, SIVA and the Research Council joined forces and created a national cluster program, called the Norwegian Innovation clusters. Today this has three levels; (1) the Arena Program; (2) Norwegian Centres of Expertise (NCE) and; (3) Global Centres of Expertise (GCE) (Norwegian Innovation Clusters, 2017). The Arena Program was initiated in 2002 as an offer to cluster projects in the early stages, and targets regional business communities within the same industry or value chain, in the pursuit of promoting increased innovation. Today, there are 19 cluster projects with an Arena-status (Arena Clusters, 2017), which receives an annual contribution between 1.5 to 3 MNOK (Norwegian Innovation Clusters, 2016). The Norwegian Centers of Expertise (NCE) Program was implemented in 2006 to support larger and more developed clusters on a national level, and targets dynamic clusters, which have established a systematic collaboration, and has the potential for growth in domestic and international markets (NCE, 2017). Today, there are 14 NCE clusters, that receives an annual contribution between 4 to 6 MNOK, determined by the cluster project size and activity level (Norwegian Innovation Clusters, 2016). The last cluster level is the Global Centre of Expertise (GCE) Program initiated in 2014. The program is an offer to clusters with a global position and a lifespan from 10 years and up, that aims towards maturing clusters that already

have a systematic cooperation in strategic areas. Within their respective sectors and technology areas, the clusters attain a global position (GCE Clusters, 2015). There are currently three global centers of expertise in Norway; GCE Blue Maritime, GCE Subsea, and GCE Node, two of which are situated within Western Norway (GCE Clusters, 2017). The GCE Program subsidizes cluster projects with an annual contribution between 8 to 10 MNOK (Norwegian Innovation Clusters, 2016).

According to Bjørn Arne Skogstad, Program leader of NCE and GCE at Innovation Norway, they are currently working on stimulating collaboration across clusters, hoping to fuel the sharing of new ideas and innovations that can ultimately create a more competitive nation.

4.2.4 Firm structure, strategy and rivalry

The context in which companies are created and managed in Western Norway reflects a solid environment for foreign direct inwards investments. The only caution lies with small local suppliers who seem to struggle alongside large multinational corporations.

Western Norway, and Norway in general, has a positive climate for inwards FDI due to its modern and stable economy and its skilled multilingual population (Santander Trade Portal, 2014). In 2015 inward FDI amounted to 1,218 BNOK (SSB, 2017: p). Private ownership has the largest share of value creation in Norwegian aquaculture, and the foreign ownership amount a total of 11 percent in the industry. It has been largely discussed whether this is negative or positive for the competitive development, but there has been a consensus that FDI and foreign ownerships occurs and grows in areas where the expertise and innovation is strong (Ulstein, Grünfeld & Ekrann, 2012).

With regards to local suppliers, suppliers of goods, services and research within the field complement the aquaculture companies. The linkages between the farming companies and suppliers of e.g. net pen cage systems, wellboats and shipyards has traditionally been closed-linked, but it does, however, seem to be a shift in this relationship in accordance with the recent significant development of technology, biology and framework conditions (Kyst, 2016: a). This can be viewed in some of the current innovation projects in the seafood cluster of Western Norway. For example, SalMar's Ocean Farm 1 rely on construction of the hull of the plant in China, as Norwegian shipyards does not support a similar

construction, and Grieg Seafood's Blue Farm rely on prototype testing in Hirtshals (Denmark) as necessary testing facilities is not available in Norway.

Further, the intensity of local competition is ranked at 69 in the GCI, which rank seems to become lower each year (WEF, 2017). Low local competition does not allow for an innovation-driven economy.

5.0 THE NORWEGIAN SEAFOOD INDUSTRY

5.1 Industrial Historical Development

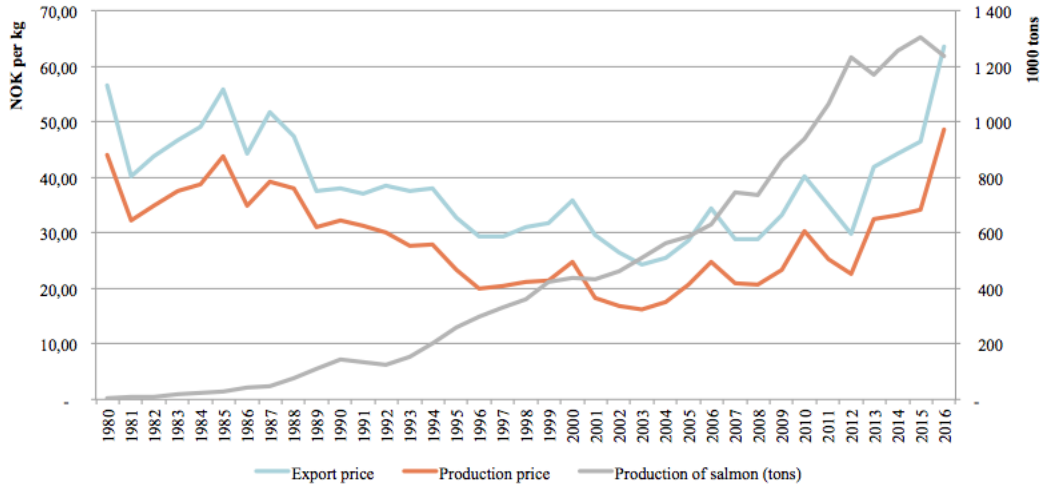
Norwegian century-long traditions and knowledge built up from fisheries in addition to a long coastline of clean, fresh seawater provides the best circumstances possible for the operation of aquaculture activities. There is no surprise that Norway was among the first nations to start with commercial aquaculture activities (Reve & Jakobsen, 2001; Regjeringen, 2007).

Up until the 1970s, the Norwegian aquaculture industry was regarded as in the pioneering phase and consisted of a small group of enthusiasts located on the coast of Trøndelag and Hordaland. At this point, the pen cages were usually wooden with a net that kept the fish inside, which had a volume of a few thousand cubic meters. The breakthrough of the industry happened in the early 1970s when the pioneers succeeded in producing salmon and rainbow trout in floating cages in the sea. This gave better growth, less risk, lower capital and operating costs than in land-based facilities. Salmon was especially important, as it was easy to promote, gave better price, hence leading to a more economic robust industry. From 1973, licenses were required for the establishment of new facilities, and the rules for localization and ownership structure made the seafood industry into a rural industry. New licenses, increased cage volume and ranging liberalization of smolt production gave production growth, market saturation and sharp price decline in the 1980s (**Figure 6**). The fall in prices with higher interest rates, bank's credit tightening and disease attacks led many companies to bankruptcy (SSB, 2017: j).

In 1991 the aquaculture law changed again, easing the restrictions of ownership, moving away from the requirements of local. Ownership concentration in Norwegian fisheries and aquaculture has since become increasingly stronger (Reve et al., 1992). Up until 2012 growth was formidable – from 133,286 tons salmon in 1992 to 972,654 tons in 2012. It has been highly debated whether

growth has been caused by productivity growth. It is clear that the growth up until the 2000s is due to productivity growth. After this, profitable expansion is due to high prices created by growth in demand, were contributing factors have been (1) innovations within fish feed, vaccinations, genetics, net pen cages etc., (2) increased expertise, and (3) better economies of scale (Tveterås & Asche, 2011; Asche et al., 2012).

Figure 6: Market development

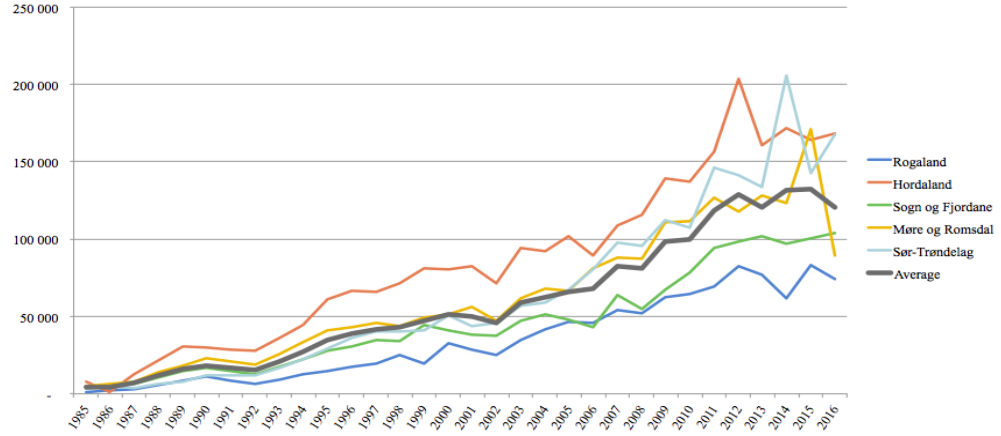


Source: SSB, 2017: k; l

5.2 Norwegian Aquaculture Today

The total world production of farmed Atlantic salmon exceeded 2.2 million tons in 2015, and of that amount Norway produced 1.3 million (Marine Harvest, 2016; SSB, 2016). Atlantic salmon constitutes 94.4% of all fish production in Norway. In 2016, the value of the export of Atlantic salmon reached 61.3 BNOK, with Europe being the largest recipient. The industry has seen a dramatic upswing the past 5 to 6 years, as the price of salmon has drastically increased. In 2011, the export price of salmon was between 30 and 40 NOK, whilst in the last weeks of 2016 the prices were as high as 73 NOK (SSB, 2017: j). This has led to a highly profitable industry with a total turnover of 74.5 BNOK in 2015 with EBIT margins reaching 30% (iLaks, 2016: a). The production volume of salmon has, however, stagnated the past 5 to 6 years (**Figure 7**). The production volume of the five largest farming companies fell from 807.546 tons in 2015 to 737.948 in 2016. The cause of the value creation the past years is hence hailed to high prices, indicating a need for restructuring and innovation (Sysla, 2017).

Figure 7: Sales of salmon in the seafood cluster of Western Norway

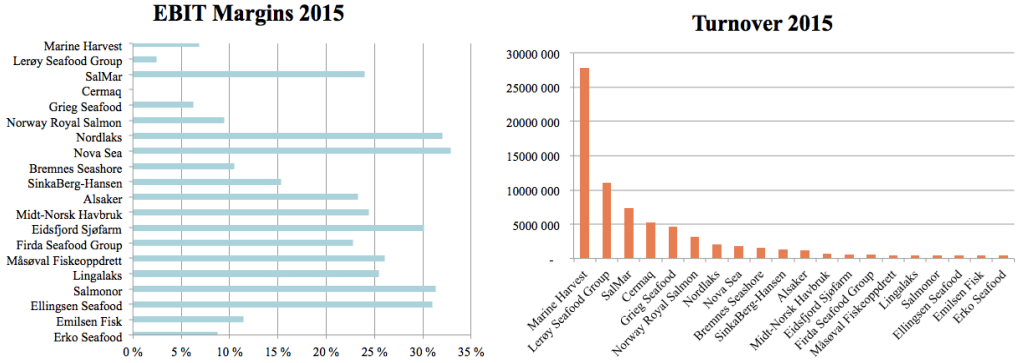


Source: SSB, 2017: k

Intergovernmental economic organizations have estimated that the total global value creation from the sea will double within 2030 (OECD, 2016: b). In Norway, however, estimations have shown that the value creation from the aquaculture sector will more than quintuple the value creation generated in 2010 by 2050 (SINTEF, 2012), and the main premises are related to the solution of the environmental challenges of the industry (Nærings- og Fiskeridepartementet, 2015: a). At this stagnation point in the seafood industry, it is evident that there are much biological and technological advancement that has to be in place for the estimations to be reached.

As of 2016, the Norwegian aquaculture industry employed 4,714 men and 667 women and comprises a total of 283 Norwegian companies with food production of salmon and rainbow trout (Fiskeridirektoratet, 2017: a). The largest farming companies today include Marine Harvest, Lerøy Seafood Group, SalMar, Cermaq, Grieg Seafood, and Norway Royal Salmon. Marine Harvest is known as the world's largest Atlantic salmon farming company, with a turnover over twice the size of the second largest Norwegian player. The company produced 400,000 tons in 2015 and reached a revenue of 27.9 BNOK alone (Figure 8 and 9).

Figures 8 & 9: EBIT margins & turnover of Norway's 20 largest aquaculture companies



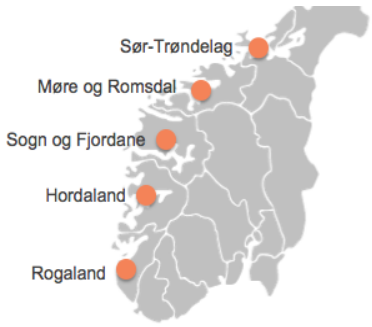
Source: Purehelp, 2017

Despite the upswing in the industry these recent years, ilaks notes that the operating profit percentages of sales has declined in both 2014 and 2015, partly due to the increased cost of fish feed ingredients, but mainly due to the extreme costs of combating sea lice (iLaks, 2016: b).

5.3 The Seafood Cluster of Western Norway

Due to the Norway's long coastline, everything from small to large seafood companies can be found along the coast. In addition, several organized cluster development programs unfolds in the country. The authors, however, wish to analyze the seafood cluster of Western Norway according to the cluster concept's definition, and find it beneficial to define the main geographical area of concern.

First, as reviewed, the authors have had contact with a cluster organization in Bergen, the NCE SIC, which up until today, confined itself to only include cluster members situated close to Bergen, Hordaland. The authors found that it was not sufficient to focus on this organized cluster alone, as several large and value contributing seafood companies, research and educational institutions are left out due to this cluster's geographical location and appraisal. Consequently, the authors decided to include a larger geographical area stretching from the county Rogaland as far as to Sør-Trøndelag. When including the other counties, significant institutions and companies can be incorporated into the thesis. Such players are SalMar, one of the world's largest salmon producers; SINTEF Ocean, Scandinavia's largest independent research institute (SINTEF, 2017); and Norwegian University of Science and Technology (NTNU), Norway's largest university; and Skretting, world leading producer of feed. Hence, the authors focus will not be on an organized cluster per se, but on a cluster of companies and institutions situated within a defined geographical area.



As several of the large industry players are situated in the Bergen area in Hordaland, and the authors obtained much of their information and contacts from the NCE SIC, a brief overview of the organized cluster will be necessary. Large industry players, among other Marine Harvest, Lerøy Seafood, Grieg Seafood, EWOS/Cargill are headquartered in Bergen, and due to the close proximity the industry players created a platform for collaboration, which today has become the

NCE SIC. The cluster dates back to 2011, when Fiskeriforum Vest (FFV) and regional development agencies started the process of formalizing cluster cooperation, supported by Innovation Norway and Hordaland County (NCE Seafood Innovation Cluster, 2015). In 2014, the NCE SIC applied for the status as a "Global Center of Expertise" (GCE), without success however. In 2015, the cluster applied for the status as a "Norwegian Center of Expertise", giving rise to the current name of the cluster, the NCE Seafood Innovation Cluster. Today the cluster contains 70 partners. The total revenue of the cluster's core industry partner was 57,7 BNOK in 2015, representing organizations with 15,000 professionals covering the cluster's industry participants and centers of R&D and innovation. The NCE SIC members in Hordaland are all Norwegian established companies, which today represent a mixture of big international companies and large number of medium-sized to small companies (NCE Seafood Innovation Cluster, 2016).

In terms of the seafood cluster of Western Norway as defined by the authors, a cluster map was created to visualize some of the cluster's largest cluster members (**Figure 10**). In the inner circle, the major industry partners, whom execute primary activities along the value chain, are represented. The five largest salmon producers, or farmers, among the main industry partners in the seafood cluster of Western Norway are Marine Harvest, Lerøy Seafood, SalMar, Grieg Seafood, and Norway Royal Salmon, whom are the five largest salmon producers in Norway (iLaks, 2016, September 12). The five largest fish feed producers among the main industry partners in the seafood cluster of Western Norway are respectively after turnover EWOS/Cargill, Skretting, Marine Harvest Fish Feed AS, Hordafôr, and Scanbio (Purehelp, 2017).

In the middle circle, the competence partners are represented, which constitutes the educational and research institutes of the clusters. These are institutions that contribute majorly to the cluster's knowledge creation, -sharing, research and innovations. The educational institutions most important to the seafood cluster of Western Norway are University of Bergen, which put great emphasis on marine research (UiB, 2016), and Norwegian University of Science and Technology (NTNU, which contribute majorly to technical solutions to the industry (NTNU, 2017: a). Other important educational institutions are the Norwegian School of Economics (NHH) and BI Norwegian Business School. The research institutions contributing to the seafood cluster of Western Norway are

institutions like the Institute of Marine Research, Nofima, SINTEF, and NIFES (Nærings- og Fiskeridepartementet, 2015: a).

Finally, situated in a highly regulated industry, cooperation and monitoring with and by governmental institutions and organizations happens frequently. Institutions of great importance for the cluster's inwards investments for research, innovations and cluster development are Innovation Norway, SIVA (the Industrial Development Corporation of Norway), and The Research Council of Norway (Forskningsrådet, 2016, May 30). Further, whatever is cultivated and harvested along the Norwegian coast is a national resource in line with the resources of the ocean. Hence, a public license must be granted for farming in Norway, and stringent requirements are imposed on technical facilities and fish welfare. The agencies holding this legislative, regulatory, and monitoring power of the industry are the Ministry of Trade, Industry and Fisheries, the Norwegian Directorate of Fisheries, the Norwegian Food Safety Authority, and the county councils of the five emphasized counties (Fiskeridirektoratet, 2015: a).

Figure 10: Cluster map of the seafood cluster of Western Norway

Source: Team analysis

According to the Norwegian Directorate of Fisheries' aquaculture register (2017: b), the seafood cluster of Western Norway consist of approximately 170 members, ranging from various small, medium, and large sized companies. **Exhibit 3** illustrates the linkages between the cluster members of the seafood

cluster of Western Norway. As evident, along with the main industry partners, the strongest linkages of the cluster are illustrated through education and research institutions, and government agencies. Particular for this cluster is the collaboration between related clusters and industries, where the marine, maritime, and oil and gas sectors are prominent, which is especially evident through the emergent innovations.

5.4 Sustainability and governmental policy

Factors inhibiting growth in the industry is said to be sea lice, escaped fish and area utilization. According to Marius Dalen, Senior Advisor at the Ministry of Trade, Industry and Fisheries, the greatest and most acute environmental challenge in the industry is the sea lice. He also mentions that in the long term the sources of fish feed will most likely be a growing issue, however, for the purpose of this thesis our focus will be on the three aforementioned challenges as these are indisputable in today's situation. Thus when the authors speak of sustainability, these three challenges will be the sole focus. The following paragraphs will give insight into what these matters entail.

5.4.1 The industry's environmental challenges

Sea lice receive much of the attention today as the most pressing issue. When one speaks of sea lice, however, one cannot simply talk about this in isolation as is it closely linked to the other acute issues as well. Sea lice has a grave effect on the situation should the fish escape and the usage of the same localities may contaminate the area, causing poor fish health which again may make the fish more receptive to sea lice.

Sea lice

Sea lice is a natural parasite which can be found on salmon, existing in all ocean areas in the Nordic hemisphere. Sea lice affects salmon by damaging its tissue and blood creating reduced welfare and possibilities of attracting other infections from bacteria and fungi. To combat the effects of sea lice on their fish population, farming companies employ one or more of the following counteracting measures: chemical bath treatments, in-feed medicines, and vaccinations. Additionally, a type of "cleaner-fish" named Wrasse is utilized to eat sea lice off salmon. As medication has been the most used combating measure the sea lice have now

developed resistance towards it, creating a more resilient lice. Due to this newly developed resilience, mechanical treatment is becoming more common. This entails using laser or brushing and rinsing with freshwater (Mattilsynet, 2016). The maximum limit for the amount of lice on fish in facilities varies with the licensing type. For regular licenses, it is set to 0.5 mature female lice per fish. This is however getting stricter. Higher levels or underreporting can lead to severe fines and, at worst, imprisonment.

The Food Safety Authority has the responsibility to follow up on the industry players to monitor that the sea lice level is kept below a certain level and decide to sanction against a company who has not remained within the regulations. According to Marius Dalen, the Food Safety Authority have instructed some farming sites to cut production, as much as up to 50%. They have and will continue to sanction where there are significant issues with sea lice. In 2015, the cost of handling sea lice and the damages caused by it reached 5 BNOK (Kyst, 2016: b). It is therefore deemed as the most pressing issue in the industry, hindering the growth both the government and the companies desires.

Escapes

The second pressing issue in the industry is the escape of farmed fish. This becomes an issue as the farmed fish may be contaminated with sea lice (or other diseases) and this can spread to the wild salmon. In fact, the Institute of Marine Research contributes farmed salmon to be the dominating factor of contamination to the wild breeds along the coast (Nærings- og fiskeridepartementet, 2015: c). Not only can diseases spread more easily, but the fish may also breed creating potentially less resilient offspring (Økokrim, 2007). In 2016 the number of escaped fish was 131,000, which is a significant decrease from 2015 when the number reached 170,000 (Fiskeridirektoratet, 2017: c). Fish escape may happen when there is failure with equipment or contact between components, often times related to heavy storms (Fiskeridirektoratet, 2015: b). With regards to escape, the Aquaculture Association for escaped farmed fish was established in 2015, with its main task of retrieving escaped fish. All permit holders for the farming of salmon, trout and rainbow trout have to pay a small fee to the association each year (OURO, 2016).

Area utilization

Area utilization has long been considered a surplus resource without a need to be controlled. However due to the rapid growth in the industry, the access to good farming localities is now seen as a scarce resource for a sustainable development. The term area utilization here refers to both the effects on the external environment and the exposure and infections happening between plants, or net-pens (Fiskeri- og kystdepartementet, 2011). The challenge regarding lack of access to good farming localities is further due to the fact that Norwegian salmon farmers do not own their production areas, as these are located in sea. Hence, the Norwegian "Aquaculture act" of 2005 and "Regulations on catch-based aquaculture" of 2014, followed by the Ministry of Trade, Industry and Fisheries, regulate such activities in territorial waters. Today, Norway is geographically divided into a total of 13 limited production areas (Fiskeridirektoratet, 2017: d), containing a total of 978 localities for aquaculture (Fiskeridirektoratet, 2017: e), wherein each locality is regulated in terms of allowed biomass produced. The total biomass or amount of salmon produced per net-pen should not, however, exceed 1,000 tons biomass or 200,000 fish. The number of localities has further decreased the past decade, as a result of the activities' impact on the surrounding environment. The environmental challenge of area utilization hence is related to the fact that all the aquaculture localities current today has been licensed out to farming companies and are in use (Fiskeri- og kystdepartementet, 2011). This issue may be the reason to the increased interest in closed contained systems (higher capacity within current localities) and offshore farming (completely new areas), and recycling plants.

5.4.2 Governmental policy

Due to an increased focus on sustainability in Norway today, the Government has introduced means to incentivize the industry to realize new technological solutions that can help solve the environmental issues the industry is facing. Three concrete measures have been implemented since 2013; green licenses, research licenses and development licenses. The Ministry of Trade, Industry and Fisheries approved in June 2013 the granting of licenses for aquaculture to reduce the escape of farmed fish and the spread of sea lice. The purpose of these so-called "green licenses" was to stimulate new technological solutions that could reduce the challenges with sustainability (Fiskeridirektoratet, 2017: f). Further, in 2014,

the Ministry of Trade, Industry and Fisheries opened its application for research licenses, where the purpose is to provide important research projects that can bring Norwegian aquaculture industry forward (Fiskeridirektoratet, 2017: g). Lastly, near the end of 2015, the development licenses were launched with a focus on substantial innovations that could resolve the environmental issues. The authors wish to elaborate on the development licenses and utilize them further in our analysis due to their topical nature related to innovation projects, as many licenses are still the application process and due to our chosen projects that we will examine in later sections.

Development licenses

Near the end of 2015 the Ministry of Trade, Industry and Fisheries launched its development licenses with the purpose of fueling investment into major technology shifts in the industry. Applications for these licenses must involve a project, which shows a considerable innovation and requires substantial investment, which can contribute to solving one or more of the environmental issues in the industry. The technologies that end up being developed in these projects is to be shared so that it benefits the industry as a whole (Fiskeridirektoratet, 2016: b). Per June 2017, 59 applications are being evaluated, 15 have already been declined and only one applicant has received full approval (for all the licenses they applied for) (Fiskeridirektoratet, 2017: h). This is Ocean Farming AS, a company established by SalMar, with an estimated investment cost of 690 MNOK. Marine Harvest AS have received approval for 4 out of 14 applications and will further their work on the "Egg" construction (Vosgraff, 2017). The application is open until November 2017 (Fiskeridirektoratet, 2016: b). Projects can have a time frame of up to 15 years and there is no limitation on the amount of licenses that can be granted, however the licensing scheme has a trial period of 2 years (Fiskeridirektoratet, 2016: b). No licenses shall be granted to equal or similar projects, as this will not help achieve the purpose of the scheme, which is to provide the industry with increased knowledge and new technology. The license is essentially free, but can be converted to a permanent license against a consideration of 10 MNOK (Fiskeridirektoratet, 2016: b). This requires that the objectives of the project have been achieved and that it is sought within 6 months prior to the license expiry date.

These development licenses have been met with great enthusiasm in the industry and the Ministry of Trade, Industry and Fisheries are optimistic towards the future. From the industry perspective, both according to Blue Farm AS and Hauge Aqua (suppliers to Grieg Seafood and Marine Harvest) what the Government is doing through these licenses is risk reduction for the companies. Rolf Solberg in Blue Farm AS believes that they are looking for something entirely new that reduces the sustainability issues and can stimulate growth. Although the risks with these new developments are high he says, so is the return. He also points to the early stages of the oil industry, where the risk was very high, but the opportunities for return and doing advanced research was equally high.

Marius Dalen pointed out that there has been an upswing of technological developments and innovations these past years, not only due to the incentives and schemes put forth by the Government but because these issues are so pressing that the industry has seen a need to make a change themselves. There are a vast number of projects and solutions worked on today, all from the biological point of view with the use of the "cleaner-fish" (Wrasse) and genomic selection to the new semi closed and closed containment systems. Marius Dalen shares the same view as Program Director of NCE and GCE at Innovation Norway, Bjørn Arne Skogstad, who believes that not one solution alone will solve these issues, but a combination, which requires cooperation within the industry. The projects that are granted with the development licenses are meant to be shared in the industry, such that knowledge is spread and the development can continue towards a better solution for the entire industry.

6.0 ANALYSIS

Through the interviews with members of the seafood cluster of Western Norway the authors obtained in depth insight and knowledge regarding the cluster on two levels – industry level and project levels. Each interview followed the same interview guides and the authors aimed to obtain much of the same information from all interviews.

The analysis section in this thesis has a three-folded structure. In the first section, the authors employ Reve and Sasson's (2012) Emerald Model to the seafood cluster of Western Norway, by applying the industrial insight obtained from the interviews in addition to secondary data collection, in the form of public documents and databases. The purpose behind this is to consider the industrial

environment of the seafood cluster of Western Norway, in order to later give implications regarding the cluster's completeness and interactions, following the conceptual model. In the second section, the authors review the innovation projects that has emerged in the cluster, incentivized by the Norwegian government's development licenses, in light of innovation theory. The aim is to characterize the innovation projects according to types of innovations put forth in the literature review, and their implications to traditional practices of the cluster. In the last section of the thesis, the authors employ the emerging innovations of the seafood cluster of Western Norway according to the sustainability concept. The objective is to later be able to regard the innovation projects as vital for the industry to overcome its sustainable challenges, namely sea lice, escapes and area utilization.

6.1 The Emerald Model

The seafood cluster of Western Norway's uniqueness is highly connected to its complementary expertise throughout its entire value chain. Various cluster members, ranging from large multinational farming giants to focused research facilities, provide the cluster with solid knowledge within the fundamental areas of the industry. Specialized suppliers of biological and technological solutions provide the cluster with the much needed knowledge pool to further lift the cluster's productivity and innovation capacity. Lastly, properly crafted governmental policies, incentives and cluster development programs contribute to systematic collaboration, increased innovation, and internationally competitive solutions.

All in all, the seafood cluster of Western Norway plays a central role in Norway's competitiveness and attractiveness globally, as it is placed at the intersection of century-long accumulated expertise and traditions from the sea and topical megatrends of radical technologies.

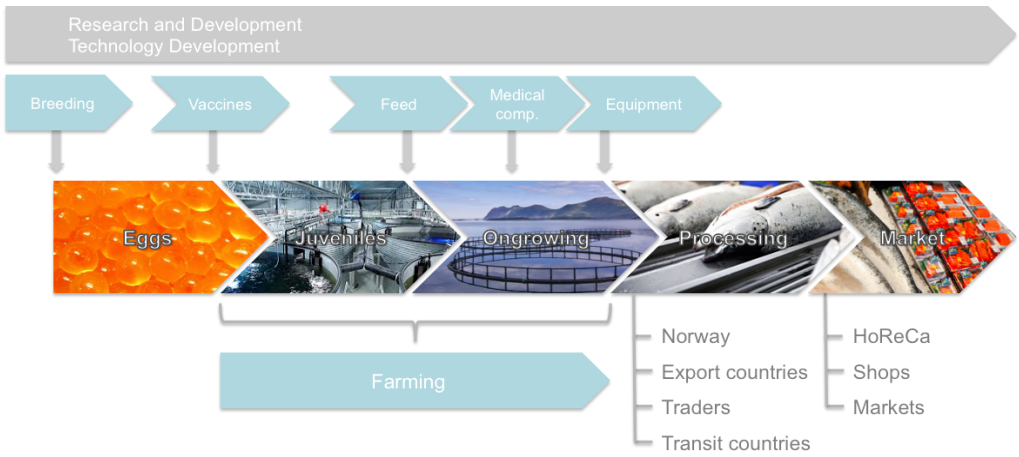
To appropriately assess the industrial environment in which the member firms of seafood cluster of Western Norway is excelling, and its knowledge pool they can build its best practices on, the knowledge-based Emerald Model put forth by Reve and Sasson (2012) will be applied.

6.1.1 Cluster Attractiveness

As the seafood industry of Western Norway is regarded as a cluster based on its geographic concentration and not by a cluster organization, the size of the cluster have to include all entities situated in Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal, Sør-Trøndelag, ranging from firms, research institutions, universities, and other institutions with activities within the value chain.

The value chain of the seafood cluster of Western Norway consists of five main activities, which are illustrated below (**Figure 11**). In the first activity, fertilized *eggs* are kept fresh water in incubation tanks. Once the eggs hatch into tiny fish (alevins) and these weigh about six grams, they move on to the second activity. Secondly, *juvenile* farming takes place in larger freshwater tanks, where the fish develops into parr. When the parr weigh around 60-80 grams they move on to the third activity. In the *ongrowing* farming the fish undertake a physiological change that enables them to move from freshwater to seawater. After 12 to 18 months in seawater, the fish will have reached market weight (4.5 to 5.5 kg) and are then ready to be *processed*. Processing takes place in specialized facilities either in Norway, in the exporting countries, at traders or in transit countries. The last activity is for the fish to go out in the market, which would be shops, markets or the hotel/restaurant/café industry (Marine Harvest, 2017: a).

Figure 11: Seafood cluster of Western Norway Value Chain



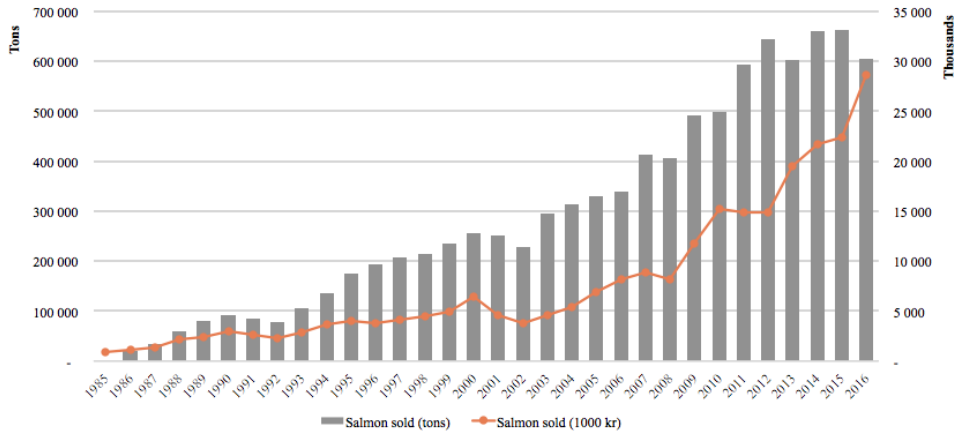
Source: Adapted from Nærings -og Fiskeridepartementet, 2015: b

Important input activities for the seafood cluster of Western Norway, and the seafood industry in general, is (1) biological breeding programs, provided by among others SalmoBreed and AquaGen; (2) vaccination and (3) feed to ensure fish welfare; (4) medical component for the fish to become resistant; and (5)

equipment for harvesting and processing processes. Supporting activities important for the seafood cluster of Western Norway is R&D and technology development.

According to Statistics Norway, the total export value of Norwegian salmon was 61.3 BNOK in 2016, amounting of 16 percent of Norway's total export value (SSB, 2017: j). Approximately 50% of this value generation came from the seafood cluster of Western Norway (SSB, 2017: k, j)

Figure 12: Sold quantity and landed value of Salmon in the seafood cluster of Western Norway



Source: SSB, 2017: k

The seafood cluster of Western Norway consists of approximately 170 members, according to the Norwegian Directorate of Fisheries' aquaculture register (2017: b). The size of these members varies from small and medium-sized enterprises to major international players. There are also many large parenting companies whom have many smaller, often family owned, subsidiaries, often covering the entire value chain. It is apparent that most of these members are primarily doing commercial farming and processing, in fact 146 companies in total. There are further about 15 firms and institutions engaging primarily in R&D (Fiskeridirektoratet, 2017: e) but there are, however, many important R&D institutions left out, as they are the subjects of larger host institutions. For example the University of Bergen is the host institution for the Sea Lice Research Centre. Nonetheless, in total, this reflect that the seafood cluster of Western Norway holds a critical mass.

By looking into the top 20 businesses, which collectively covers the entire value chain, it is also apparent that this critical mass holds both a horizontal and vertical structure (**Exhibit 4**). The structure is horizontal as there are several competing firms at the same level of the industry, e.g. Marine Harvest, Lerøy

Seafood, SalMar, Grieg Seafood, and Norway Royal Salmon are all engaging in salmon farming. The structure is vertical as there are several firms that separately engage in different levels of the value chain, e.g. Marine Harvest covers the entire value chain, and Lerøy Seafood engages in farming, processing and sales (Purehelp, 2017).

According to Tanja Hoel (Managing Director, NCE Seafood Innovation Cluster), the competitive and knowledge advantage of the Norwegian aquaculture industry can be divided according to four regions. First, the Oslo area is recognized as attaining the regulatory strengths of the industry, as this is the power capital of Norway. Second, the Bergen area is recognized as attaining the strengths within the biological aspects of the industry. Third, the Trondheim area is recognized as attaining the strengths within the technical and supplier aspects of the industry. Lastly, the Tromsø area is recognized as attaining the strengths in the aspects of knowledge and the arctic conditions. This is also the area with the greatest potential for growth, according to Hoel. Hence, the competitive advantage specific to the seafood cluster of Western Norway is the knowledge within the biological and technical aspects of the industry, as well as connections to the industry and cross-industry suppliers.

As reviewed, the value creation generated from the member firms of the seafood cluster of Western Norway has had a consistent increase in terms of sales and exports the past decades. The over 170 member firms hold both a horizontal and vertical structure that covers activities throughout the entire value chain, and it is clear that they have access both to a national and international critical mass. It is evident that the competitive advantage of the cluster is obtained from its complementary expertise within the cluster, wherein the southern part of the cluster is strong within the biological aspects and the northern part of the cluster shows great expertise within the technological aspects. It is hence possible to define the industry of Western Norway as an excelling industrial cluster within seafood.

6.1.2 Educational Attractiveness

For any industry to stay competitive there must be an inflow of qualified labor into the industry. According to the NCE SIC status report for 2016 one of the areas where the seafood industry is lagging is in education and talent attractiveness (NCE Seafood Innovation Cluster, 2016). This is also one of the

focus areas within the new ocean strategy the Government put forth in February (Regjeringen, 2017: c). According to action 7 in the strategic business plan for the Bergen region 2015-2020, the goal is to strengthen students' competence in educational choices, where the cluster has a central role in improving the collaboration between Upper Secondary schools and the industry (RegionBergen, 2015).

In Hordaland, the NCE SIC have signed a partnership with two upper secondary schools to connect students with the industry as early as possible in their education (NCE Seafood Innovation Cluster, 2017). Along the coast from Hordaland up to Frøya in Trøndelag one can find five other upper secondary schools with studies within marine subjects (Studievalg, 2017). Frøya VGS actually has a license to do fish farming and is renting this license out to SalMar, Marine Harvest and Lerøy Seafood, which has generated an income of 28 MNOK for the school (DN, 2015). According to an article by "Sett Sjøbein", an organization which operates as the seafood industry's tool for recruitment and elevating competence, the outlook for 2017/2018 is very positive. In fact, for the aquaculture-subject, upper secondary schools have had in increase of 30% in applicants and an increase of 56% in the number of girls applying, compared to 2016 (Sett Sjøbein, 2017).

Moving on to higher education, there are specifically three universities within our cluster that contribute to the seafood industry. First and foremost, the University of Bergen, who since the fall of 2016 offer an integrated Master's program, which mixes biology and science with elements of innovation and economics (UiB, 2017). According to Sigurd Stefansson, professor at the Dept. of Biology at UiB, the industry players in Bergen requested candidates with a larger width in their background, which thus resulted in the creation of this master. The university also offers a Master in Biology and integrated Master in Aquamedicine. Despite the efforts of creating a new Master's program the industry desires, the first semesters of the program are taught in Norwegian and the program for now only has the capacity of 20 students (26 students were accepted of the 53 applicants in 2016). The Aquamedicine Master program has room for 25 students, an increase from only 10 in 2016 (UiB, 2017: a). UiB is tightly connected to the research community and has identified marine research as one of the main research areas. The university hosts among others the Sea Lice Research Centre, appointed by the research council of Norway. In addition, eight other centres of

excellence are connected to the university, including centres within research-based innovation, marine ecosystems and climate research. Such close ties may give students insight into the current issues in the industry, and a more practical insight to how the research community operates (UiB, 2017: b).

In the same region, the Norwegian School of Economics (NHH) is situated, which have created a new MBA, also due to the initiative from the NCE SIC. This MBA program is taught in English and rooms a total of 32 students. In addition, it has a tuition fee of 370,000 NOK (NHH, 2017).

Further North we find Høgskolen i Ålesund, which since January 2016 merged with Norwegian University of Science and Technology (NTNU), Norway's premier institution for the education of engineers (NTNU, 2017: b). NTNU Ålesund had an increase of 15% applicants in 2015, which was double the nationwide average (Meland, 2015). They offer a Bachelor within Marine and Biological subjects. Lastly, NTNU in Trondheim offers a Bachelor within Biology and Master program within Marine Technology. NTNU has close ties with the industry. It has had a collaboration with SINTEF since 1950, and is in fact voted the number one university in the world with regards to cooperation with an industry partner, by the Financial Times. According to Nils Røkke, executive vice-president for sustainability at SINTEF: "this link gives SINTEF valuable 'access to talent', including PhD students, as well as access to high-quality labs and equipment" (Morgan, 2017). NTNU is also a partner in eight Centres for Research-based Innovation, among others CrlAqua where we find important partners such as Nofima, UiB and Marine Harvest. Another center is the Exposed Aquaculture Operations, where SINTEF Ocean, SalMar and Havforskningsinstituttet are partners (NTNU, 2017: c). This shows the close collaboration NTNU has with the industry, both the players in their near proximity such as SINTEF and SalMar but also the institutions further South such as Marine Harvest and Nofima.

NHO conducts a yearly survey where they rank Norwegian municipalities according to their attractiveness and growth potential. Within the competence indicators the municipalities were measured on magnitude of individuals with technical and science education, population with more than 4 years of higher education and according to the proportion of its population holding apprenticeship examinations. The highest ranked municipalities had a high percentage skilled

workers and had cities with educational institutions. Half of the 20 highest-rated municipalities were in Western Norway (NHO, 2016).

As presented, there are certainly efforts made in elevating the interest and possibilities for young students to choose a career within the aquaculture industry. The question however; is it enough? The industry is demanding skilled labor with higher education, and despite the efforts in creating a new Master's program, only around 25 people (at best) will graduate after 5 years, and the lack of internationalization of this master will signify that most of these will be Norwegian i.e. little diversity in students. Further, despite well-respected universities such as NTNU and UiB offering biology, there is no certainty that these students will end up in the seafood industry.

6.1.3 Talent Attractiveness

According to a report by the Ministry of Trade, Industry and Fisheries (2014), Norway has the most expensive and demanding labor force. Companies in the seafood industry must therefore do a series of measures to compete with other attractive sectors. That labor is expensive may simply reflect its scarcity, and what it can contribute to in alternative applications. The seafood industry has been competing for talented labor with the oil and gas sector for several years, which has represented one major challenge for the development of the industry. Having skilled personnel at all levels of the value chain is crucial for further growth and until recently talented young professionals have been drawn towards the oil and gas sector due to high salary levels and interesting jobs (SINTEF, 2012). Due to major downsizing in the oil and gas sector, many highly educated people are looking to industries, which can provide better job security in the long run. In 2016 NAV received around 17,500 announced layoffs stemming from the oil and gas-industry, with Rogaland being the county that was most affected (Sysla Offshore, 2017). The new HR director at Grieg Seafood vows to make the seafood industry the most attractive place to work. She herself came from the oil industry, and now wants to aggressively promote both nationally and internationally, capturing new talent with increased branding and portraying the innovative and sustainable focus of the industry (Enerwe, 2016).

The seafood industry's attractiveness in the labor market is not only a function of its ability to pay, but also a number of other factors. The Norwegian employee is highly demanding with factors such as a challenging academic and

social working environment, amenities in the nearby community, availability of sports and culture, and employment and educational possibilities for its family members all affect how attractive an industry and company become. Talented professionals tend to have a spouse with higher education who wants a relevant job related to their education. Many of these factors suggests that people with higher education wants to settle near or in more urban areas with large supply of various jobs and services (Nærings- og Fiskeridepartementet, 2014).

The industry's attractiveness also hinges upon its ability to offer attractive career paths. As the aquaculture industry is still very young many companies are still small and often family owned, which have not been deemed attractive by graduates with higher education. However, the seafood cluster as defined by the authors stretches past three of the largest cities in Norway, namely Stavanger, Bergen and Trondheim. These cities have well established amenities and are developed cities attractive for young talent. Thus, it is natural that talent who are often graduates from these cities move on to jobs either in the same city or to any of the other two cities. Despite that Oslo is a very attractive city for young talent, many of the largest seafood companies are headquartered in Bergen, Stavanger and around the Trondheim region. Thus, this is the most natural place to begin your career when graduating within marine subjects. Further, Trondheim won the most “attractive city” award in 2015, appointed by the government. This price is an award for the most sustainable city- and community development (Regjeringen, 2016). Additionally, Trondheim has the largest share of students relative to its population, which creates an environment attractive for young professionals (Trondheim Kommune, 2016). Tanja Hoel (Managing Director, NCE Seafood Innovation Cluster) also mentioned in an interview that the cluster was cooperating with the municipality of Bergen to create different programs to integrate foreign workers who come to Bergen to work. She points to the recent acquisition of EWOS, by the American company Cargill where EWOS gains access to an international HR-network, which may increase both the company and Bergen´s visibility. In its strategic plan for 2013-2025 Stavanger has identified the need to attract more talent to its city, and vow to do this by strengthening the connection between the industry and universities, and creating a better and more attractive city for students (Greater Stavanger, 2013).

Moreover, large industry partners such as EWOS, Grieg Seafood, Marine Harvest, Lerøy Seafood Group and Salmon Group have increased their efforts in

capturing new talent and started a Seafood Trainee Program in September 2016, where they combine work at a seafood company with an academic program in Bergen, Trondheim and Paris/Brussels (NCE Seafood Innovation Cluster, 2016). The aim of this program is to increase the visibility of the industry nationwide. The program will allow graduates to rotate within several areas of the industry and is designed to train future leaders in the seafood industry (iLaks, 2015).

With regards to foreign talent in the industry, it seems like the industry is still lagging. Marianne Wøbbekind, Senior HR consultant in Marine Harvest, said in an email that of their 150 employees in Bergen, she estimated that around 14 are expats. Considering the capability of attracting international talent to join as board members and other management positions, of the 6 largest industry players only EWOS Group states that they do not discriminate based on nationality and language (EWOS Group, 2015, April). In fact, Marine Harvest and Grieg Seafood only have 4 non natives employed as top management out of 18 and SalMar, Lerøy Seafood and Norway Royal Salmon solely have Norwegian natives as top management, which portraits little diversity in these positions (Marine Harvest, 2017: b; Grieg Seafood, 2017: a; SalMar, 2017: a; Lerøy Seafood, 2017: a; Norway Royal Salmon, 2017).

The ripple effects from the downturn in the oil and gas industries could have a positive effect on the attractiveness of the seafood industry with regards to talent. Talent attractiveness is closely related to the educational offerings, hence now in the coming years we might see a positive change due to the new focus both from the government and the industry in creating more specific educational offerings within seafood. The location of the cluster is regarded as attractive for Norwegians, however attracting foreign talent to Norway still seems to be challenging.

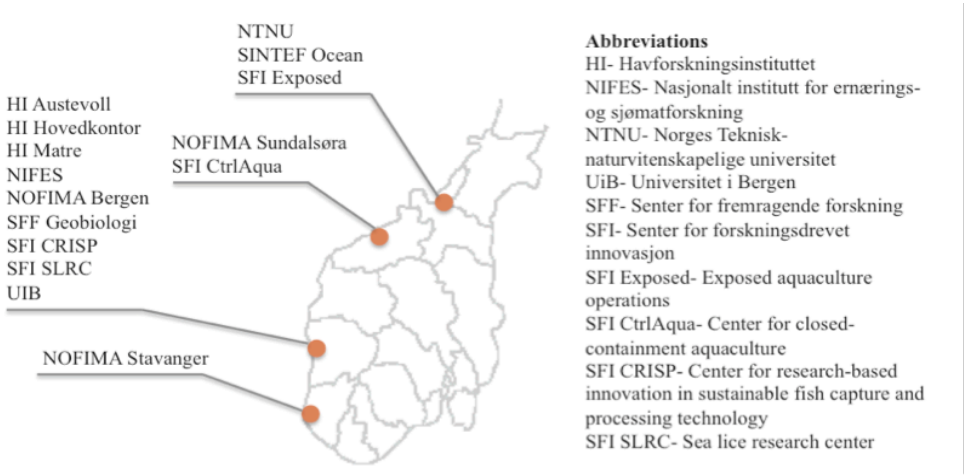
6.1.4 R&D and Innovation Attractiveness

The Norwegian aquaculture industry is a leading global industry, with an international high level of knowledge, leading suppliers in several technology areas and major research and development capacity. The Norwegian salmon farming industry has, however, experienced stagnation in growth and many claims this is largely caused by reduction in R&D and innovation intensity (Asche et al., 2012).

The Norwegian government has taken several initiatives, especially after the sustainable goals put forth by the UN and the climate agreement in Paris in 2015 (Solberg & Valseth, 2016). Since this, Norway has received considerable political attention, as the nation has chosen to focus on R&D in order to achieve the objectives. The Norwegian government communicates their main goal of contributing to the greatest possible sustainable value creation in the ocean industries, wherein one of the three strategies is to facilitate knowledge and technology development through research, innovation, education and competence. The government has hence conducted a significant strengthening of policy instruments facilitating for R&D and innovation in companies (Regjeringen, 2017: c).

It is evident that Norway has a significant amount of marine R&D and innovation, which is funded both publicly and privately. The majority of the public marine research funding is directed toward basic biological issues within the aquaculture industry. In 2015, the total R&D spending was 3.12 BNOK, in which governmental funding accounted for 2,386 MNOK and private, or sectoral, funding accounted for 734.9 MNOK (Regjeringen, 2017: c; SSB, 2017: m). According to the Ministry of Trade, Industry and Fisheries there is approximately 40 actors in the higher education sector and institute sector that is involved in marine research (Nærings- og Fiskeridepartementet, 2015: a). In terms of location, more than 60 percent of this marine research takes place within the seafood cluster of Western Norway.

Figure 13: Key marine research environments in the seafood cluster of Western Norway



Source: Nærings- og Fiskeridepartementet, 2015: a

The institutional sector is strongly represented in Hordaland and Rogaland, where the main focus is marine biology. Within the largest research environment

one can find the Institute of Marine Research (Havforskningsinstituttet), Nofima, the Norwegian Veterinary Institute, and NIFES. The Institute of Marine Research is the largest research environment, which manages 25.8% of the Ministry of Trade, Industry and Fisheries budget in 2017 (Nærnings- of fiskeridepartementet, 2016, December). Other institutes in Hordaland and Rogaland with large marine R&D activity include SFI and SFF. The institutional sector in Sør-Trøndelag and Møre and Romsdal is strongly represented within marine technology, and includes SINTEF Ocean, SFI and Nofima. In terms of the universities and higher education executing R&D and innovations, the locations of the institutes differs in terms of approach. It is evident that there is wide biological focus being in the Hordaland region, and a technical focus in the Sør-Trøndelag. The University in Bergen (UiB) is one of the largest educational institutions in marine research, in which marine R&D accounts for approximately 30% of total R&D expenditure. At the Norwegian University of Science and Technology (NTNU) the marine R&D accounts for 8% of total R&D expenditure (Sarpebakken & Røsdal, 2015).

As revised, Norwegian aquaculture has experienced stagnation in growth the past five to ten years, due to what many blame on reduction in R&D and innovation intensity. After governmental initiatives largely connected to sustainable goals, R&D and innovations has once more gained a leading focus in the industry. Governmental funding towards R&D and innovations has traditionally been directed towards the institutional and educational sector, and private funding has traditionally dominated in the private sector. Much has changed after the government's increased focus on the "green shift", as incentives have boosted innovation activities. The R&D and innovations in the private sector does, however, still largely depend on private funding. Nevertheless, it is fair to regard the seafood cluster of Western Norway as a cluster that capture a major part of the research and innovation activities that happens in the industry today.

6.1.5 Ownership Attractiveness

Oslo Stock Exchange is the world's largest financial marketplace for the seafood industry, in terms of number of companies and value (Nærings- og Fiskeridepartementet, 2014). Early in 2017, DnB Markets recommended the purchase of the Marine Harvest stock, and predicted a high dividend due to the prospects for the four new development licenses and the progress related to the start-up activity on the east coast of Canada (Hegnar, 2017: a). In February,

Marine Harvest announced a cash dividend of 2.80 NOK (Marine Harvest, 2017: c). Pareto also expresses optimism regarding both Marine Harvest and Lerøy Seafood Group in 2017 (Hegnar, 2017: b). Despite some optimism from analysts, Chief Investment Officer Pernille S. Christensen, at Carnegie Norway, has cut salmon stocks for around a quarter of a BNOK. Christensen claims to be concerned about the potential slowing demand (due to high prices) and the high cost levels linked to combating sea lice. She has reduced the aquaculture-portfolio from 18% to 8%, which includes a reduction in Lerøy Seafood Group by one percent, Marine Harvest by four percent and SalMar by more than two percent (Hegnar, 2017: c). Another huge investment company Periscopus, owned by Trygve Hegnar, recently sold around 1.7 million of their shares in Marine Harvest, however has not yet commented on the reason for this sale (DN, 2017). Despite mixed optimism, the stock prices have hit record high levels in 2016 and thus the seafood cluster are becoming increasingly attractive both to the public and to private investors. Further, the commitment by the government to transform Norway to an ocean nation and the new development licenses might again trigger investors to invest more into this industry.

According to the Ministry of Trade, Industry and Fisheries (2014), the industry's capital requirements will increase, partly due to its expensive labor. The capital must stem from investors that will demand competitive, risk-adjusted return compared to other alternative investment opportunities, both in other industries and countries. Further, in terms of specific investors, Marine Harvest, Lerøy Seafood, Austevoll Seafood and SalMar have close connections with Sarsia Seed, Connect West and Holberg Triton (Holberg Fondene, 2016). The latter is the world’s largest private investment fund for seafood business. DnB, Norway’s largest state owned bank, are also close collaborators in terms of specialized advisors and loans in all stages of development.

With regards to foreign investors, Invest in Norway was established in 2013 as a collaboration between Innovation Norway, SIVA (the Industrial Development Corporation of Norway) and The Research Council of Norway. This was created to provide services to foreign companies establishing and investing in Norway (Invest in Norway, 2015). As China will become the world’s largest outward investor within 2020, Innovation Norway, the Royal Norwegian Embassy and Invest in Norway hosted the 3rd Norway China Investment Conference, in September 2016. The focus was on bio and ocean economy, and invited

companies within among others the marine sector, technology clusters and marine clean tech (Persson, 2016). Another major source of FDI stems from the US. The recent acquisition of EWOS by the American feed giant Cargill for 12.3 BNOK will be very significant for both EWOS and the industry. Cargill has vast experience in buying and integrating businesses, and creating value by combining talent and expertise from the companies they buy. Cargill has aquaculture operations in Mexico, Central America, China, the United States, Southeast Asia, India and Ecuador (EWOS, 2015, August 17).

Considering the other large industry players along the West coast, they are all privately owned by Norwegian holding companies, with a slight exception of Marine Harvest whose largest shareholder is Geveran Trading CO LTD listed in Cyprus however owned by the well-known investor John Fredriksen (Marine Harvest, 2017: d). Marine Harvest, Grieg Seafood, Lerøy Seafood Group and SalMar are also owned by The Government Pension Fund Norway (Folketrygdfondet) by a small percentage, ranging from 3.5-8% (Marine Harvest, 2017: d; Lerøy Seafood, 2017: b; SalMar, 2017: b; Grieg Seafood, 2017: b). Some degree of state ownership is still quite common in large Norwegian companies. Skretting, the world's largest feed producer for farmed fish, is wholly owned by Nutreco, a global animal nutrition and aqua feed company based in the Netherlands (Skretting, 2017).

With regards to the overall ownership attractiveness it seems like the industry is attractive due to its position on the well known stock exchange, and because of that is under constant observation by analysts which thus necessitates a well functioning management. Several firms are owned by deeply rooted Norwegian firms and well-known investors, adding to the credibility of the industry and the belief that predominantly competent investors would invest in this cluster.

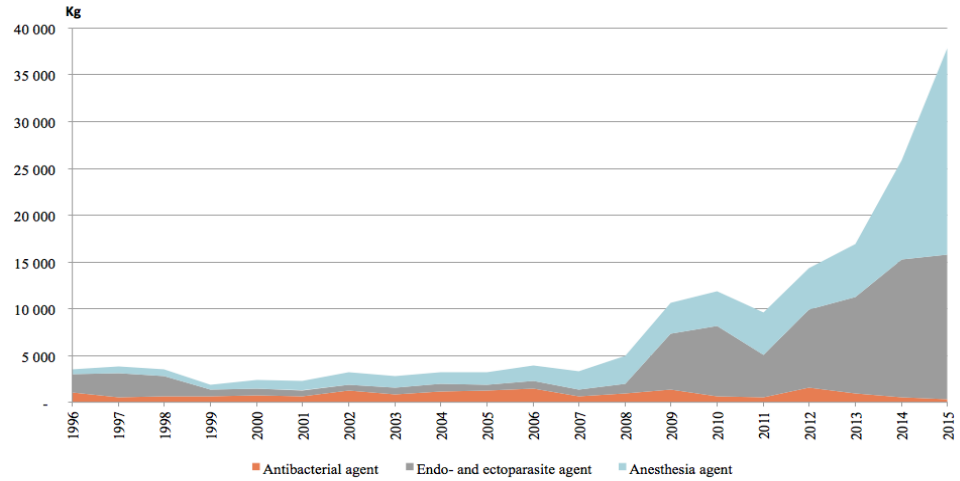
6.1.6 Environmental Attractiveness

As elucidated under point "6.0 The Norwegian Seafood Industry", it is evident that the Norwegian aquaculture industry has undergone a tremendous growth. Such growth is usually hand in hand with challenges regarding environmental and sustainable growth, as this growth is not suppose to compromise the needs of future needs. In addition, the Norwegian seafood industry is estimated to quintuple its value creation within 2050 (SINTEF, 2012). In 2009, the Norwegian

government launched a strategy for an environmental sustainable aquaculture and highlights sea lice, fish escape and area utilization as the factors that negatively impacts the environment and a sustainable growth in the industry (Regjeringen, 2009). The environmental profile of the seafood cluster of western Norway will hence be evaluated according to these factors. Particular for Norwegian aquaculture is also its reputation, especially related to these three challenges.

The presence of *disease and sea lice* can be reflected through the use of pharmaceutical drugs in the industry, which clearly has increased the past ten years (**Figure 14**). The use of antibiotics has been reduced the same period, while the use of agents to reduce the impact of parasites has increased (SSB, 2017: j). Sea lice has been a problem ever since Norwegians started farming salmon, and in the early stages of the industry, pharmaceutical agents were used to cope with the sea lice. However, the sea lice developed resistance for these agents, which may explain the growth since 2008. Ingunn Anita Wergeland (Advisor, Sea Lice Research Centre) explained that later on, bio scientific methods such as functional feed, new medicines, vaccinations and methods handling resistance development has been in focus. She emphasizes the importance of using multiple solutions to combat the sea lice problem, such as mechanical solutions in interaction with biological ones.

Figure 14: Use of pharmaceutical drugs in aquaculture



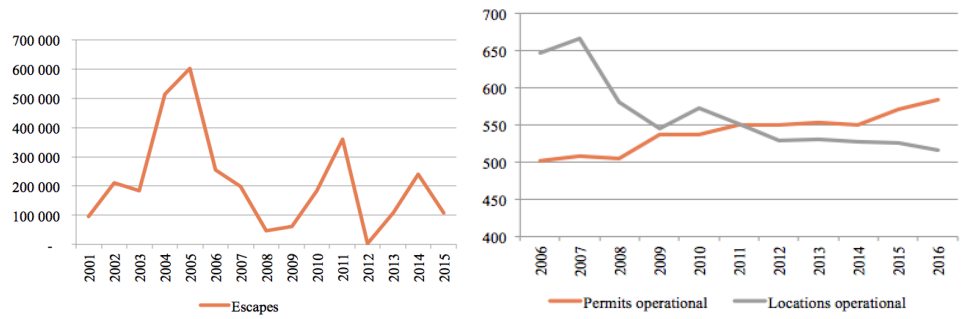
Source: SSB, 2017: j

The amount of escaped fish in the seafood cluster of Western Norway is highly cyclical as the cause of most escapes in recent years is plant breakdowns, bad technical conditions of the facilities, human error, predators and predation through nets, collisions, poor inspection and working practices, lack of control and lack of competence of the breeder (**Figure 14**)(Regjeringen, 2009). The

problems connected to escaped farmed salmon are two-folded. First, there are the biological challenges, including disease, sea lice and genetic "pollution" of wild salmon through escapes. This challenge is hence highly reinforced by increasing trends in disease and sea lice. Second, is the reduction of production losses. The problem of escaped fish has hence been attacked from several angles, such as expansion in area utilization, location structure, choice of suitable sites, smolt/ juveniles quality and concentration of fish farms at one location (Tveterås & Asche, 2011). Borghild Hillestad (Genetics Manager, SalmoBreed AS) explained that the industry has existing biological solutions today; for example, by producing triploid eggs the farmed salmon will be sterile, so it cannot breed other salmon, including wild salmon.

The number of *localities* along the coast of the seafood cluster of Western Norway has in fact been reduced by 120 localities in ten years; however, the number of permits allocated has increased by 70, indicating a high production within a limited geographic area. The government wishes to facilitate for efficient area utilization that can give the greatest possible production within a limited geographic area, without unacceptable environmental impact. To achieve this, the industry is dependent on efficient spatial- and suitability structure, which will ensure positive development for spread of diseases, pollution, biodiversity etc. for the external ecosystem, as well as the growth, welfare and health of farmed fish (Regjeringen, 2009). It is evident that the Norwegian coast cannot support the growth in the seafood industry; however, R&D and innovations focusing on this environmental challenge have risen lately. Examples of such projects are SalMar's Ocean Farm 1 and Marine Harvest's Egg. The first one expands the aquaculture locations from the coastline to the open sea, while the second one exploit the current resources close to the coastline more efficiently.

Figure 15&16: Escaped salmon & number of localities in the seafood cluster of Western Norway



Source: SSB, 2017: n; o

In addition to the current solutions to the environmental challenges inhibiting growth, the Norwegian government focuses on an environmental friendly and sustainable industry. This is evident first in the strategy for an environmental sustainable aquaculture in 2009, and second in the ocean strategy of 2017. The results of these strategies have been among others the green- (2013) and development (2015) licenses, which has been environmentally beneficial for both the industry and its firms. Much of this work is reminiscent of what Porter and Linde (1995) explain to be a properly crafted environmental regulation of the industry.

As assessed, the seafood cluster of Western Norway, and the industry in general, has undergone a tremendous growth that has created a heated discussion regarding environmental and sustainable growth. This discussion has been highly connected to the growth inhibitors of diseases and sea lice, escaped fish and utilization of locations. Even though many of these problems are dynamic and interrelated, it does create new business opportunities, especially in the form of innovations due to the shifted focus and incentives of the Norwegian government. If successful, the environmental profile of the seafood cluster of Western Norway, and the industry in general, will have a positive change.

6.1.7 Knowledge Dynamics

While the previously explained dimensions describe the foundation of the knowledge pool and the conditions under which firms can excel in a cluster, being the industrial attractiveness, knowledge dynamics determines whether the firms can utilize these conditions to their benefit. Knowledge dynamics can be measured through the knowledge linkages between the actors in the industry and with actors in related industries (Reve & Sasson, 2012). According to Reve and Sasson (2012) the firms utilize the dimensions though knowledge interaction, cooperation and rivalry, and the seafood cluster of Western Norway hence have to be reviewed and considered accordingly. In accordance with the thesis's context, the member firms of the seafood cluster of Western Norway collaborate on the emerging innovation projects incentivized by governmental policies. According to Porter (1998) such collaboration is the essence towards better productivity and innovation.

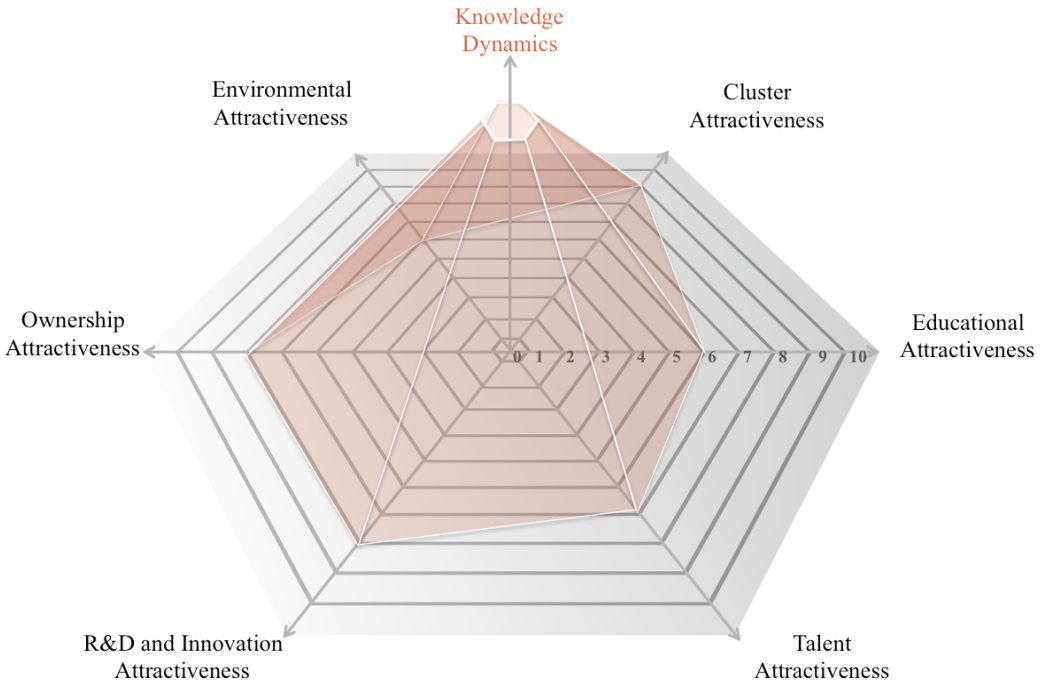
From the above reviewed dimensions, it is no doubt that the seafood cluster of Western Norway attains a knowledge pool necessary for the firms to

excel. Innovation Norway contributes to the stimulation of the knowledge linkages in-between firms through the NCE-program. Bjørn Arne Skogstad, program leader of the NCE- and GCE program, however believes that the actors doing innovation and R&D projects should be more open-minded with regards to where suitable and relevant collaboration parties can be found. He mentioned a need to shift focus from solely looking at internal cluster collaboration or international collaboration, to looking to other industries in Norway that may contribute to creating new standards. For example, one opportunity could be to utilize the expertise in lightweight material from the clusters situated in Raufoss. This becomes especially important now that new ocean constructions are surfacing. The seafood industry needs to look towards milieu that has specific technological knowledge that they themselves do not possess.

This expansion of knowledge pool and interactions is also a topic in the NCE SIC in Bergen. Tanja Hoel (Managing Director at NCE Seafood Innovation Cluster) argued that they have had a focus on elevating the cluster itself, but are now looking towards other industries and organized clusters for collaboration. Further North, in Trondheim, one can see that the collaborations between industries is ongoing, with SINTEF and NTNU's long tradition of collaboration. The Ocean Space Center is one example of this where the efforts from biology, engineering and technology are combined to provide researchers the necessary means to study topics within marine and maritime, all from renewable energy production to ship design and the future of fish farming (SINTEF, 2013).

For now, it seems as the knowledge flows between firms inside the industry is somewhat strong, with the strong connections and interactions in Hordaland and the commitment of the large industry players in that region to seek more towards the Trondheim region for collaboration. Additionally, the new focus of Innovation Norway advising clusters to engage in cluster to cluster activities and the governmental incentives through the development licenses to share knowledge hopefully will have a positive effect on the knowledge dynamics between actors, and related industries, heightening Norway's competitive position and possibly resulting in new growth industries.

6.1.8 Conclusion of the Emerald Model



Through analyzing the seven dimensions of the seafood cluster of Western Norway's Emerald Model, the cluster's *cluster attractiveness* scored the highest score of 9. This score is justified by the cluster's complete horizontal and vertical value chain and by the international degree of its cluster members. Following the authors has scored both Ownership- and R&D and innovation attractiveness as 8. *Ownership attractiveness* is scored this high due to its listing on the world's largest stock exchange for seafood companies, in addition to many firms being owned by well-known investors deeply rooted in the Norwegian economy, both privately and state owned. *R&D and innovation attractiveness* is also rated at 8 due to the well-established research institutions located both in Hordaland and Sør-Trøndelag. Further, the cluster receives the majority of public investments within marine research. The cluster scores slightly lower on the *talent*- (7) and *educational* (6) dimension as these areas have been somewhat overlooked by the industry. Educational offerings to date have not been sufficient, as only a limited number of graduates complete each year and due to the interconnectedness of these two dimensions the talent attractiveness is ranked similarly. However, due to the location of the cluster and its recognized cluster members, the authors believe that the talent would see this as an attractive cluster to commence their careers. *Environmental attractiveness* is ranked at 6, as the industry has been troubled with environmental issues such as sea lice for some time. These issues does create

business opportunities in terms of innovation, but the result of these can however be question by the fact that such issues are dynamic due to development of resilience. *Knowledge dynamics* receives the score of 6, as the industry in Western Norway have a strong knowledge base stretching from South in Stavanger to North in Trondheim, that is utilized through interactions and collaboration in R&D and innovation projects. Through the analysis the authors do, however, see an unexploited potential in knowledge and expertise linkages both in-between counties and across other national industries as, in some cases, international knowledge has been obtained.

6.2 Innovations in the seafood cluster of Western Norway

With regards to the increased focus on research and innovation the recent years fueled by governmental investments and competitive ambition, it is evident that many of the innovation projects have come to life within the seafood cluster of Western Norway. In fact, regarding the green licenses from 2013, about 38 percent was awarded to companies situated within the seafood cluster of Western Norway. Among the development licenses from 2015, 68 percent of the applications came from companies situated within the seafood cluster of Western Norway. Ocean Farming (SalMar) and Hauge Aqua (Marine Harvest) are two of five companies awarded development licenses as of today (Fiskeridirektoratet, 2017: h, f).

6.2.1 Presentation of innovation projects

As there are many innovation projects that have emerged from the seafood cluster of Western Norway, the authors went through an elimination process to choose the proper projects to analyze. The authors wish that the nature of the projects explained in this part of the analysis capture the essence of the chosen theory as well as the innovation and technology focus of the industry. The choice of what innovation projects to include in the elaboration of the thesis was hence dependent on several factors.

First, the project needed to be in line with the chosen theory of this master thesis, being clustering and innovation, in addition to the outcome factor of sustainability. This implies that the firms executing the project is situated within the seafood cluster of Western Norway, that the project is somewhat groundbreaking and substantial and that the objective of the project is to solve one

or more of the environmental issues and the growth limitation straining the industry. The latest development licenses offered by the government captures both innovations that are substantial and innovations that solve one or more environmental issues, hence the authors searched for suitable projects that had applied for these licenses within the cluster.

Second, as there are several different types of innovations that meet the above requirements. They do, however, tend to have different approaches to the environmental challenges by executing different forms of innovations – as mentioned in the introductory sections, technological, biological, and commercial innovations. The authors aim to limit the chosen innovation to include technological innovations, entailing solutions and systems that aim to replace the traditional net-pens for post-smolt and on-growth production of salmon. Several members in the seafood cluster of Western Norway believe that this production activity will be replaced with closed containment systems and offshore open-net pen systems, which will hence be those innovation projects analyzed. Lastly, the authors have limited the chosen innovations according to availability for data collection. Hence, those innovations projects exposed in the analysis have foundation in interviews with employees of the cluster member firms executing the projects.

The Egg

The Egg is a new closed containment farming technology that is developed through a joint venture project between Marine Harvest Norway AS ("Marine Harvest"), Norway's largest seafood company, and Hauge Aqua AS ("Hauge Aqua"), a Norwegian technology supplier.

The Egg will be 44 meters high, 33 meters wide and 90 percent of the construction will be below water. Each egg will eventually be able to accommodate 1,000 tons of salmon (iLaks, 2016: b). The closed cage system ("CCS") holds the geometrical shape of an egg that protects the salmon from external forces. The CCS has a unique circular water flow that allows the system to draw inlet water from separate places from where outlet water is released, wherein the inlet water is collected from water below 38 meters. The water quality and volume can hence be controlled, ensuring sound oxygen levels and de-gassing. The inlet water entry ensures that sea lice do not enter the pen, as the lice's natural habitat is in the top water layer. The feed is supplied through

existing feeding systems both from above the water and submerged. An expandable fish grid does harvesting and emptying the tank when moving down and filtering fish (Hauge Aqua, 2017).

Picture: The Egg

Source: Hauge Aqua, 2017

In an interview, Geir Atle Rød, Hauge Aqua's Business Development Director, explained the background and motivation for the Egg project. He elucidated that the current aquaculture production platform is too weak to sustain growth, as it does not tackle the problems of the industry. Hence, when pondering how to get the industry to grow, Cato Lyngøy, the CEO got the idea of the Egg. The Egg was also in line with Hauge Aqua's ambition is to provide a competitive and sustainable alternative production platform. This was the background for what is today one of Norway's most mentioned technology.

In February 2016, Hauge Aqua and Marine Harvest signed a development agreement including financial support and full scale testing. Subject to the agreement was that Marine Harvest applies for 14 development licenses (Hauge Aqua, 2016). Alf-Helge Aarskog explains that Marine Harvest's motivation for the project is to enhance the competitive advantage the Norwegian aquaculture industry already has through sheltered coastal areas. The Egg represents a new direction, and is a lead in the development of CCS (iLaks, 2016, February 11).

The egg aims to replace the traditional open net pens and offers many advantages to traditional salmon farming. Geir Atle Rød explained in his interview that the sustainable advantages are linked to the fact that the new CCS is able to control the salmon's environment. A controlled environment enables better fish welfare, in the way that the CCS collects the waste, maintaining control on feed and the appropriate ecological levels. In addition, the Egg contributes to solving the three main sustainability problems of the industry.

On the 10th of February 2016, Marine Harvest applied for 14 development licenses, wherein 1 license allows the company to test the pilot, 2 licenses allow them to test 2 prototypes, and the latter licenses allows them to test the system in the large-scale phase in 10 production units. On the 25th of November 2016, the Norwegian Directorate of Fisheries rejected the application as regards to 10 of the licenses applied for, but decided to proceed with the latter 4 licenses. The total investment cost when proceeding with these 4 licenses is around 245 MNOK (Fiskeridirektoratet, 2016: c).

Ocean Farm 1

Ocean Farm 1 is an offshore farming technology developed by SalMar ASA ("SalMar") through its subsidiary Ocean Farming AS ("Ocean Farming"), which was established to develop the project.

The construction will be 68 meters high, 110 wide and maintain a volume of 250,000 cubic meters. Ocean Farm 1 is a slack anchored semi-submersible, rigid structure, with a high degree of stability that floats with depths of 100 to 300 meters. The salmon can be handled internally within the plant without using external boats and equipment. In addition, the plant is equipped with a sliding bulkhead and two fixed bulkheads that allow the plant to be divided into three zones for exercising various fishing operations. The plant is automated and heavy manual operations are avoided. It is built such that a daily staffing of 3-4 persons for monitoring and control operations is sufficient. Current risk analyzes support that the plant is considered to be highly escape proof. Ocean Farm 1 will be the world's first offshore aquaculture net pen, and builds on the same basic characteristics as semi-submersible offshore installations as in oil and gas, and is thus an interdisciplinary collaboration between leading players and expertise in Norwegian aquaculture and offshore industry (SalMar, 2017: c).

Picture: Ocean Farm 1

Source: SalMar, 2017

In an interview, Arvid Hammernes, Managing Director of Ocean Farming, explained that the underlying idea and motivation behind Ocean Farm 1 was SalMar's desire to develop technology and infrastructure, and to take the operation out in more exposed areas. Thus, Ocean Farming AS was established as a subsidiary, where multiple external parties with different expertise, both from salmon and offshore, was brought in and placed in this project.

At large, Ocean Farm 1 contributes to solving two of the main sustainability problems of the industry. According to Hammernes, the concept of Ocean Farm 1 contributes to efficient space utilization by opening up and make use of new locations for aquaculture that offer better biological conditions for farming. These are areas that are less affected by tidal currents and where the direction of current is more constant. And as mentioned, the cage system will be highly escape proof.

As of today, SalMar holds 16 licenses, eight of which goes under the green licenses of the announcement round in 2013/2014, and eight of which goes under the development licenses of 2015. With the allocation of the green licenses, SalMar committed itself to adopt technological or operational solutions that reduced environmental problems compared with those in commercial use (SalMar, 2016). After applying for eight development licenses on the 27th of November 2015, the Norwegian Directorate of Fisheries announced and pledged on the 26th of February 2016 all eight of SalMar and Ocean Farming's licenses for aquaculture for development purposes for a period of 7 years (Fiskeridirektoratet, 2016: e). SalMar is the only company who has been granted all their desired development licenses.

Ocean Farm 1 is now under construction in China, and is to be placed in Frohavet outside Trøndelag early in the second half of 2017. The plant will be a full-scale pilot where many aspects of operating salmon farming offshore will be tested (SalMar, 2017: c). Total investment cost for the eight licenses will be 690 MNOK.

6.2.2 Departure from traditional practices

As reviewed earlier, what characterize the current seafood cluster of Western Norway are a complete value chain, high profitability and great potential for growth, with impediments of a young industry. The traditional practices related to farming includes first, land-based smolt production in freshwater tanks on land up

until the juvenile salmon has reached about 70 grams, and then second, on-growth production in open net-pens in sea (**Figure 17**)(Marine Harvest, 2017: a).

Several of the cluster members have expressed their opinion of how the future farming activities and technologies will look like. Some believe that, within 5 to 10 years, the farming activities will be a threefold production, where the smolt is still produced in land-based freshwater tanks, and then enters closed-cage systems ("CCS") either land-based or in sea. Finally, the salmon will be transferred to an open-net pen for the on-growth production (**Figure 17**, Future salmon technology alternative l) and ll)). The new aspect introduced is hence the intermediate phase for post-smolt production in CCS, which holds either recycled seawater or flow of seawater currents. None of the current CCS innovation projects in progress that applied for green or development licenses is, however, land-based (alternative l)). The reason for this might be that the Norwegian farming companies do not want to give up the competitive advantage that comes with a long coastline. If the entire production process of salmon could be situated on land, any country in the world could become competitors of Norway (Nilssen-Meyer, 2016). Essentially, what's new with the CCS is that the farmers are able to isolate the salmon from pathogens like sea lice as they control the supply and quality of the seawater.

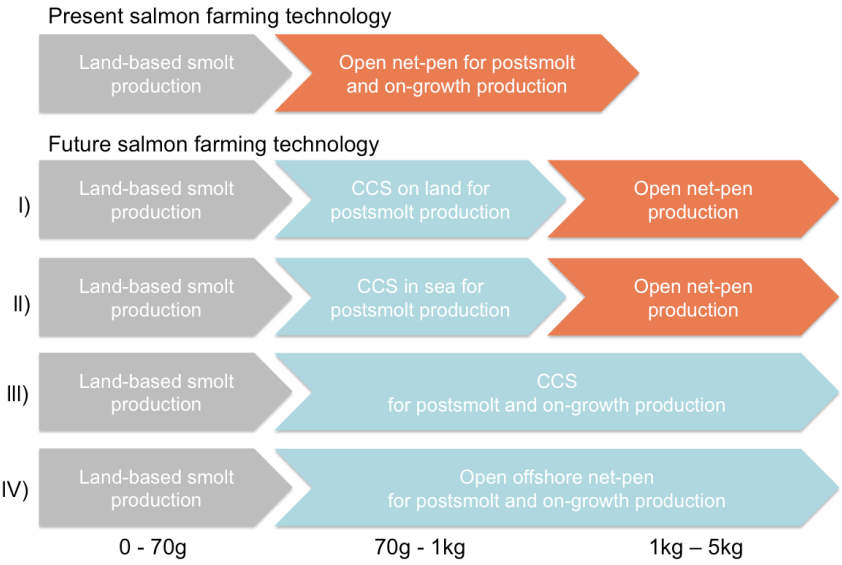
Other believe that, within 5 to 10 years, the farming activities will still be a twofold production, where the smolt is still produced in land-based freshwater tanks, and then enters either CCS in sea or offshore open net-pens for post-smolt and on-growth production, where the salmon lives until ready for processing (**Figure 17**, Future salmon technology alternative lll) and lV)). One example of such a CCS is Marine Harvest and Hauge Aqua's innovation "the Egg", and one example of such an offshore open net-pen is SalMar's innovation "Ocean Farm 1".

Marine Harvest's innovation, the Egg, is regarded as a radical and sustaining innovation. As brought forth by the incremental vs. radical paradigm, the Egg reflects a profound departure from the current farming activities of the company, which is traditional inshore open net-pens. The innovation includes new practices and materials that is novel to Marine Harvest, wherein the incumbent have attained a new stream of technological knowledge through Hauge Aqua. The Egg brings with it benefits that traditional methods do not hold, in addition to the sustainable advantages, which will be discussed closer later. The new technology

includes a cage system that; can easily be transported to the farming locations; possesses a shape that provides full protection against sea lice and predators; holds optimal upward water circulation; accurate feeding with minimum feed spill; easy collection of feces particles; and precise harvesting through a fish grind that filters the fish ready for processing (Hauge Aqua, 2017). The Egg is permitted to hold a maximum of 1,000 tons biomass, which is the same as the average traditional open net-pen cage (Fiskeridirektoratet, 2016: c). Further, as brought forth by the sustaining vs. disruptive paradigm, the Egg targets the current established customers with the aim of better performance as previously available through the open net-pen cages. As theory has it, a disruptive innovation introduces something simpler and less expensive to new or less-demanding customers. The Egg is neither simpler nor less expensive and targets the same customer base.

SalMar's innovation, Ocean Farm 1, is also regarded as a radical innovation as the traditional practice of inshore open net-pen for post smolt and on-growth production is replaced with an offshore, anchored, semi-submersible net-pen construction. The innovation includes traditional infrastructure recombined with new practices and materials that is novel to SalMar. The incumbent have attained a new stream of technological knowledge through obtaining personnel that is particular knowledgeable of offshore technology though the establishment of Ocean Farming AS. Ocean Farm 1 brings with it benefits that traditional methods does not hold, in addition to the sustainable advantages, which will be discussed closer later. The new technology includes an offshore open net-pen that; possess a submersible structure to provide a more natural ecosystem for the salmon through ocean currents; automatic and internal handling of operations; and a durable equipment and structure to avoid the forces of nature (SalMar, 2017). Ocean Farm 1 is permitted to hold a maximum of 6,240 tons biomass, compared to the average traditional open net-pen cage's 1,000 tons biomass (Fiskeridirektoratet, 2016: f). Further, as brought forth by the sustaining vs. disruptive paradigm, Ocean Farm 1 also targets the current established customers with the aim of better performance as previously available through the open net-pen cages. In addition, Ocean Farm 1 is currently an expensive and technological complicated solution.

Figure 17: Present vs. future farming technologies



Source: Team analysis

It is hence evident that both the emerging innovations in the seafood cluster of Western Norway are radical sustaining innovations, as they change and challenge the traditional practices related to farming by introducing new solutions in the aim of better performance to existing well-established customers. Other than new practices and technologies that changes the present farming activities, the radical innovations brings with them sustainable advantages, that the authors will elucidate in the following section.

6.3 Sustainable implications

6.3.1 Characterization as sustainable developments

It is further important to ask the question whether the radical sustaining innovations of the Egg and Ocean Farm 1 are sustainable developments. As put forth by the World Commission, an environmental sustainable development meets the requirements of resources in the present without compromising the earth and its ecosystem in the future. As elucidated, the environmental problems concerning the seafood cluster of Western Norway, and the seafood industry as whole, are sea lice, fish escapes and area utilization and the innovation projects hence has to be analyzed according to these problems.

Marine Harvest and Hauge Aqua's innovation the "Egg" will evidently solve all the three main sustainable impediments of the industry. This is primarily hailed to the geometric structure of the CCS as well as its functionality. The egg-

structure is fully enclosed with a unique water flow that draws inlet water through pumps placed 38 meters below sea level, which is then circulated upwards (Hauge Aqua, 2017). According to Geir Atle Rød (Business Development Director, Hauge Aqua AS), the problem of escaped fish is further resolved due to the enclosed construction and secured water inlet and outlet placed 38 meters below sea level. The two latter problems is further coincided as they make sure that sea lice and disease infection between plants at the same location does not happen, as there is no way for the salmon to escape or that it has lice in the first place, which brings us over to the last environmental problem, area utilization. With the environmental advantages the Egg brings with it, controlled disease infections and waste levels, the salmon farmer can produce more salmon per plant (or Egg), and have more plants (or Eggs) per location. Rød further adds that the Egg uses less space compared to the traditional open net-pens and can produce 50kg/m3 (up from 25kg/m3) if regulations are adapted to such new technologies. A result is hence an environmental production of a larger volume of salmon.

SalMar's innovation Ocean Farm 1 carries a different approach to the environmental problems of the industry by bringing the farming activities offshore, and evidently solves all three main sustainable impediments of the industry, with primarily focusing on area utilization. The traditional locations for salmon farming are placed in in-shore areas, where poor tidal currents affect the plants, and the directions of the currents are more constant. With Ocean Farm 1, these in-shore areas are replaced with offshore areas wherein the tidal currents are no longer a problem in addition to other more optimal biological conditions for aquaculture. SalMar hence solve the environmental challenge of area utilization by moving production out from the in-shore areas that is already running on full capacity, in relation to both volume and environmental impact, and opens new untouched localities that allows for environmentally efficient area utilization and increased production. SalMar's test locality, Håbranden, is, however, situated in Frohavet in Sør-Trøndelag, which does not differ significantly from the traditional locations. The test locality will hence not itself contribute to more efficient area utilization, but the Directorate of Fisheries assumes that successful development and testing means that Ocean Farm 1 will utilize areas that would be difficult to use with today's traditional equipment (Fiskeridirektoratet, 2016: f). Further, due to the fact that Ocean Farm 1 is placed in areas with more favorable conditions, the innovation brings with it favorable developments in terms of sea lice and

waste levels, as more powerful currents gives greater degree of water replacement in and around the net-pen (TU, 2016). Lastly, executed analyzes also substantiate that the structure is considered to be highly escape-proof.

It thus seems like the Egg and Ocean Farm 1 are environmentally sustainable developments in line with the World Commission's definition.

6.3.2 One size fits all problems?

In this progress of developing sustainable solutions for the industry, several members of the seafood cluster of Western Norway have shared their perspective on which innovations show the greatest promise in addition to new emerging challenges that new solutions brings with them.

Representatives from both Blue Farm AS and Hauge Aqua states through their interviews that they view the development licenses obtained from the government as risk reduction measures for the associated firms, as the government has through careful analyses chosen what project that they believe shows the greatest promise in terms of contributing to the sustainable and technological challenges of the industry. When looking closer at the development licenses, all the five innovations granted investments by the Norwegian government are either semi-closed- or closed contained systems, or offshore open-net pen systems (Fiskeridirektoratet, 2017: h), which reflects the government's belief in these types of novel technologies.

On the North Atlantic Seafood Forum 2017 representatives from CtrlAqua, Marine Harvest, and the Norwegian Parliament debated the emerging innovations. Bendik Fhyn Terjesen (Director, CtrlAqua) believes that the CCS solutions show great promise. The reason is due to the simple fact that in CCSs one has a closed wall compared to a net-pen cage with several thousand square meters of water intake. The water intake for CCS in no more than one to two square meters, and it is therefore much easier to control. For example, in open net-pens, oxygen levels have shown to drop to zero, while in CCSs the farmer can control that, and basically make the internal environment to the quality that suits the farmer, or the fish welfare. Hence, in addition to favorable development in terms of sea lice, escapes and area utilization, the CCS technologies do not overlook or go beyond fish welfare (Terjesen et al., 2017).

With this argument one can consider the offshore open net-pen systems to be less favorable than the CCSs, as it is not possible to control the water intake in

the same way, as it in fact becomes more difficult with the more powerful water and tidal currents in the offshore areas. But as reviewed, the offshore open net-pens provide more optimal conditions, e.g. more suitable ecosystem for farming than traditional methods (Fiskeridirektoratet, 2016: f). As Øyvind Oaland (Global Director for Research, Marine Harvest) explained, one important characteristics of the industry is that salmon farmers does not own their production area, as these are located in sea, which brings with it crossing interests as it impacts other public and farming locations. The offshore open net-pen systems hence focus more on relieving current farming location by opening up to new areas wherein farming activities does not affect the open environment as much as it is currently doing. Additionally, as a result of new areas, or locations, for farming comes increased production and export out of Norway (Terjesen et al., 2017).

A factor that recurs in many interviews among governmental institutions (Innovation Norway and the Ministry of Trade, Industry and Fisheries) and the educational institute (UiB) is the concern regarding sea lice. Marius Dalen (Senior Advisor, Ministry of Trade, Industry and Fisheries) states that despite the challenge with sea lice, he believes the industry is going in the right direction with the development of new sustainable innovations. He adds that many good solutions were brought to light from the green licenses in 2013, but we still have a way to go in terms of realizing future sustainable growth. When asked what solution he saw to the environmental issues, he stated that a combination of both biological solutions and new and improved technological systems could be the answer.

Optimism regarding the closed containment systems was also evident, from UiB, NCE SIC and Hauge Aqua, with Hauge Aqua stating that this will potentially be the industry standard in the years ahead. However, Marius Dalen, states that despite the positivism regarding closed containment systems, the industry must think further. The sea lice issue may be solved in the short term, however what are the long-term implications of this system? He expresses concern regarding fish-welfare in closed systems with much higher densities of fish than in fish farms today. Tanja Hoel also portrays concern regarding fish-welfare and states that the cluster organization must have a holistic view and think long-term as the individual companies has a more short-term focus. Further she states that this is an industry, which have very strict regulations regarding sustainability. With such strict regulations regarding sea lice, this often becomes

the sole focus of a company, and despite that these regulations might be needed, it is important that these regulations are not at the expense of other species or the ecosystem.

Members of the seafood cluster of Western Norway, both farmers, researchers and politicians, seem to have reached a common consensus that it is not given that one solution will solve the problems, but rather a variety of different ones combined on different levels of the value chain.

6.3.3 Promoting growth or sustainability?

In the term sustainable growth, the authors consider both environmental sustainability and economic sustainability to be of importance. As seen from theory, environmental- and economic sustainability is tightly interconnected in this industry, meaning that economic growth cannot be realized without environmental sustainability (World Commission, 1987). With that in mind, in the following section the authors wish to utilize the conducted interviews to better understand the industry's views on the development licenses and the implications that may come of it.

In order to reach the goal of the fivefold production growth in the aquaculture industry within 2050 (SINTEF, 2012), the government has had to intervene in the industry and incentivize the seafood companies to fix the environmental issues prior to increasing volume. As we remember from Porter and Linde (1995), strict environmental regulation could lead to higher efficiency and promote innovations that can increase competitiveness. The idea behind the latest development licenses is that these new projects would help increase the innovation level in the entire industry and that they would contribute in solving one or more environmental problems which ultimately leads to higher growth in the industry. In addition, the knowledge from these innovations must be shared, to benefit the entire industry. This implies that these steps towards sustainability should not only mean creating a handful of sustainable companies but is an effort in creating a sustainable industry (Fiskeridirektoratet, 2016: f). It thus seems like the government is taking steps in creating a Norwegian "super-cluster" within seafood.

According to Bjørn Arne Skogstad, the companies in the cluster have not been good enough at sharing knowledge and working across clusters. He claims that the push from the government now is the drivers for change, and that to be

first movers in the industry the companies must cooperate and create efficient innovations. SalMar has looked beyond its own industry and cooperated with companies from the offshore-industry, which is Innovation Norway goal for the future of the industry.

Øyvind Oaland, research director at Marine Harvest, spoke at NASF and said essentially what the government is doing with the new licenses is sharing some of the risk with the companies. Testing out a radical innovation, without any backing is something very few companies have the opportunity to do. As the development licenses are essentially "free" it may allow smaller firms to participate as well. These two factors, reducing risk and evening out the playing field, are mentioned as positive outcomes from an environmental regulation in Porter and Linde's (1995) article.

With regards to the actual volume increase, the chosen innovations will in total contribute to an increase of 9,160 tons salmon, which is roughly 1.2 million salmon for SalMar and 620,000 salmon for Marine Harvest (Fiskeridirektoratet, 2016: f, c). Considering the optimism regarding these types of closed systems and the opportunities that opens should the Ocean Farm 1-project become successful this may become the standard in the industry which opens up for more efficient area utilization, and highly escape proof systems, i.e. reducing the contamination of sea lice. If the projects keep their promises regarding reducing the sustainable issues, these new innovations can ensure growth in the industry, whilst still being sustainable.

On the notion of economic sustainability, an important question to ask is how profitable these innovation projects are for the companies granted development licenses. There are some criticisms regarding the licenses from several parties stating that these licenses favor large companies due to the heavy investment cost and that the process is very slow. Despite successful projects and granted development licenses, only a limited number of companies can afford to create the same/similar solutions due to the high investment cost. Consider SalMar versus another smaller farming company (Company X). SalMar is investing 690 MNOK in the Ocean Farm 1 project, plus after the completed project period (7 years) they can convert their development licenses to ordinary licenses for 10 MNOK each. In total for eight licenses that will be 80 MNOK. Should Company X decide do the same and invest in a similar Ocean Farm, they must first invest 690 MNOK into the project, and simultaneously buy licenses in

the market, with a market price which today is estimated at around 60-70 MNOK. This would add up to at least 480 MNOK, considering the need of eight licenses. Hence, should Company X decide to initiate such a project, an investment of approximately 1.2 BNOK is required, which can be regarded as a substantial innovation expenditure. Based on the salmon prices seen today, the investment cost can be manageable and profitable in the long run. But, should the salmon prices drop to the levels seen in 2011 and 2012, Company X will spend years breaking even, if breaking even at all.

The concern regarding the time it takes to get acceptance on these licenses was a recurring topic at the NASF conference. The longer it takes for the government to go through these applications, the longer the projects must be put on hold and the industry may potentially be lagging behind other, more efficient countries regarding new innovations. Porter and Linde (1995) warn about creating such a lengthy regulatory process, as it will not be beneficial for the development of the projects. Marine Harvest were quite outspoken about this process during the debate at NASF and are very eager to commence. Further criticism can be found in the media, claiming that these licenses only focus on creating new technology that will increase the growth that the government and the industry players want. There is no limit for how many licenses a company can apply for, and no limit for the total amount of licenses that will be granted. According to Erik Sterud, head of Norske Lakseelver, this contradicts the White paper 16 (Meld. St. 16.) concerning predictable and environmentally sustainable growth in Norwegian salmon and trout farming. The concern is therefore that the technology and growth is the driving force of these innovations and that they will reduce the environmental issues is only a smokescreen (NRK, 2016; DN, 2016).

Throughout the talks with the representatives, it has been difficult to decipher if the companies are genuinely concerned about the environmental issues or if creating growth for them individually is the primary focus. This question will remain unanswered until the projects become initiated and operative.

7.0 DISCUSSION AND CONCLUSION

In the following section, the authors will first discuss the propositions suggested in the conceptual model in section 2.4. For empirical reasons, the propositions

will be discussed in light of the findings obtained from the analysis and theoretical foundation. Lastly, the authors will answer the research question.

7.1 Proposition 1

As suggested, Proposition 1 is two-folded: *Clusters hold a high capacity to innovate when obtaining a) a complete value chain, and b) strong knowledge relations and interactions.* To sufficiently discuss Proposition 1, the authors will first consider Proposition 1a and Proposition 1b separately, while later discuss them coincidentally.

P1a) Clusters hold a high capacity to innovate when obtaining a complete value chain.

Following the thesis' conceptual model, the seafood cluster of Western Norway is regarded to attain *cluster completeness*. As reviewed, the Emerald Model's six first dimensions (cluster-, educational-, talent-, R&D and innovation-, ownership-, and environmental attractiveness) provides the foundation to consider whether the cluster attain the appropriate completeness in terms of resources, knowledge and expertise across the value chain to be regarded as a global knowledge hub.

The authors found that the seafood cluster of Western Norway scored especially high on the dimensions of cluster-, R&D and innovation-, and ownership attractiveness. These findings was a result of the complete horizontal and vertical value chain covered by both the cluster's multinational and small-medium-sized companies, well-established research institutions, and investment flows via governmental institutions and the world's largest seafood stock-exchange. Additionally, the authors found that the cluster's specific competitive advantage is the knowledge and expertise within the biological and technical aspects of the industry, as well as connections to the industry and cross-industry suppliers, which was especially evident when considering the two largest cities in the cluster, Bergen and Trondheim. These characteristics reflect the very essence of what makes Norwegian aquaculture special – globally leading knowledge environments (Reve & Sasson, 2012). It is hence in place to say that the seafood cluster of Western Norway possesses the appropriate knowledge pool through its cluster members in addition to a favorable industrial environment, for the industry as a whole to excel.

P1b) Clusters hold a high capacity to innovate when obtaining strong knowledge relations and interactions.

Considering the seafood cluster of Western Norway's knowledge dynamics, it is evident that there exist cluster interactions within the cluster. As reviewed, knowledge relations and interactions can be deciphered through the Emerald Model's seventh dimensions, knowledge dynamics, and appears through interactions, collaboration and synergies among the cluster members.

The authors found that the most evident patterns of collaboration are between the firms in the Bergen-region, and the firms in the Trondheim-region, that occurs through the leading research environments' projects and cluster development programs. According to respondents who are currently members of the NCE SIC in Bergen, knowledge sharing and collaboration happens frequently and is valued. This includes 1-2 meetings a month in which the members share experiences and progress in the different projects they are collaborating on. Hauge Aqua disclosed that they have applied to be a member of the organized cluster in Bergen, strictly due to the closeness of its partners and the knowledge-sharing they thus may benefit from. Such ease of knowledge dissemination within regional clusters is evident in theory (Isaksen, 2009).

Behind most of the collaborative innovation projects that the authors have come across within the seafood industry along Western Norway, at least one educational institution, one research institution and often several industry players of different purposes has been involved. It thus seems that different contributors are included in the projects to ensure sufficient complementary knowledge and expertise, and that knowledge flows and synergies are occurring, as innovation projects is in the very center of such activities.

Despite this, the authors question the very strength of these interactions, collaboration and synergies. The authors found exclusive collaboration projects happening between the research and educational institutions and farming companies in the Bergen-region that strives towards collaborating with the firms and institutions within close proximity. These tendencies are well known within cluster theory, but how strong should they be? The organized cluster located in Bergen, NCE SIC, includes partners that reside in the Bergen-region. Although Bergen is well known for its specialized educational and research institutions which are world-leading within biological advancements it would most definitely be beneficial to consider collaborating with a larger part of the cluster. Tanja Hoel

(Managing Director, NCE Seafood Innovation Cluster) agreed upon the importance of this and stated that their primary concern of recent years has been to build their organized cluster and has not yet had time to collaborate with other companies outside the Bergen-region. Innovation Norway stated this as an issue as well, claiming that cluster organizations become very inward focused, and that the need now was to motivate cross-cluster and cross-city collaboration. Due to the great knowledge potential existing within these communities, it is essential that the knowledge links strengthen in order to further the cluster of Western Norway.

Clusters hold a high capacity to innovate when obtaining a) a complete value chain, and b) strong knowledge relations and interactions.

To sum up, the seafood cluster of Western Norway obtains a complete value chain and to an extent strong knowledge relations and interactions, following the seven dimensions of the Emerald Model, which hence implies that the cluster holds characteristics of high capacity of productivity and innovation. The only caution lies with the strength of the exclusive knowledge links residing in the Bergen-region, as the cluster at whole will have a greater foundation to excel if a greater critical mass is considered in collaborative activities and knowledge-sharing.

7.2 Proposition 2

P2 – Environmental sustainability can be achieved through innovations triggered by governmental policies

Today's open-net pen technology has proven to be limited in terms of creating growth and solving the environmental issues in the industry. There is consensus amongst the respondents that the future will consist of a mixture between closed containment systems, land based systems and offshore open-net pen systems. As Marius Dalen stated, there has been an upswing of innovations and technological development in recent years, stemming from the industry itself and not only spurred by governmental regulations. Bjørn Arne Skogstad, adds that there has been mini-projects creating "small clusters" within the cluster where companies have cooperated on innovation projects. It seems, as there is a common understanding in the cluster that there is a need to resolve the environmental

issues, and due to the close contact between the cluster members the innovation level within the cluster has elevated.

However, from the conversation with Marius Dalen, the authors understand that many innovations have been incremental, connected to the improvement of practices and methods for limiting the sea lice levels. Few have been radical, as theory describes radical innovations are "less common" due to the risks, investment cost and uncertainty (McDermott & O' Connor, 2002). Both The Egg by Marine Harvest and the Ocean Farm 1 by SalMar were mentioned by several respondents while on the topic of radical innovations. The attention that the development licenses have gained in the industry, plus the immense investment costs and risks these companies are taking obviously creating attention towards these projects. SalMar's offshore-farming project, Ocean Farm 1, started back in 2012, collaborating with players both within and outside the cluster, but had not yet been realized until the development licenses were offered possibly due to the high risks associated of creating a one of a kind offshore farm. This coincides with what Porter (1990) claim to be one of the distinctive causes of innovation, namely changes in governmental regulations. It thus seems like the environmental regulations are a somewhat determining factor in rendering these projects feasible. The last question remaining is whether these innovations in fact can resolve the sustainability issues in the industry. All in all, the respondents agreed that the innovations, or solutions, would solve the most pressing issues, but no one would declare that these innovations would solve the issues on an industrial level. Many were reluctant to speak of the future, which is quite understandable as it would only be speculation. However, all respondents agreed upon that the solution most likely would consist of a combination of technological innovations and biological research.

In sum, as stated in the discussion, environmental sustainability must prevail before allowing for economic growth. In this case, these innovations will most probably increase the production volume i.e. the growth in the industry. If the regulation is properly crafted, which in this case means strict enough so that these projects in fact does eliminate one or more environmental issues, sustainability may be achieved. However, should the environmental issues be ignored further, there will be no growth, and the industry is back to square one.

7.3 Conclusion

The aim of this master thesis was to collect empirical indications and evidence of the relation and effects of innovations on sustainability in the seafood cluster of Western Norway. Introductory, the following research question was outlined:

> *How can the seafood cluster of Western Norway, with respect to its completeness and interactions, resolve the sustainable challenges in the industry through innovations?*

Throughout the research and analysis conducted in this thesis, it has become evident that the seafood cluster of Western Norway is a complete cluster with positive knowledge flows, but still has potential to prosper in terms of strengthening the linkages and knowledge sharing between members. The authors consider the recent innovations brought forth by Marine Harvest and SalMar to be sustaining and radical and a product of both an increased innovation level in the industry in general and a push from the government in terms of the development licenses. In fact, without the development licenses it is hard to say if these projects would be realized. If the development licenses are properly crafted and carried out, they should in theory benefit the whole industry, making it sustainable, meaning eliminate or reduce the issues of sea lice, fish escapes and area utilization and thus contribute to growth. Due to the stage these projects are in, a definite answer cannot be given at this time. In addition, due to the severity of the sea lice issue, the authors agree with the common belief that a technical innovation alone cannot solve this issue; it must be solved in combination with a biological solution. This cluster possesses the necessary tools, hence the authors are positive for the future of the seafood industry of Western Norway.

8.0 CHALLENGES & LIMITATIONS

For the conducted case study it is important to clarify the challenges and limitations. First and foremost, the major limitation is related to the primary data collection of the research. Here, the challenges were related to the access to adequate interview objects and quality of information obtained from the interview. To reach and maintain a high level of reliability, the authors aimed to interview as many company representatives as possible, as they are a part of a greater whole,

namely a cluster. The authors, however, found it difficult to grant access to representatives within the most interesting innovation projects in the cluster within the given timeline. Further, the authors followed the interview guide template in all the conducted interviews, and strived to get the same information from all the interview objects. However, each interview provided their own level and depth of information, including different levels of both objectivity and subjectivity on the topics. In addition, some interview objects refrained from some of the interview topics due to the projects classification. Despite these challenges, relevant secondary data through public documents backed up the analysis, which allowed the authors to make progress in the analysis.

Secondly, the thesis' generalizability and replicability can be questioned based on the number of representatives interviewed and the number of innovation projects that the authors wished to elucidate deeper in. The authors interviewed in total twelve company or institution representatives, and one might have achieved different data and ultimately different results if more interviews were conducted. Further, the authors decided to go deeper into two radical innovation projects, The Egg and Ocean Farm 1. More projects to elucidate further into might have provided the authors with more insights and perhaps different results. The authors found, nevertheless, that the chosen projects were representable according to the selected theoretical variables and provided both complementary and supplementary information to the analysis.

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10.0 EXHIBITS

Exhibit 1 – Interview Guides

Interview Guide #1

Introduction

- Introduction of interviewer(s)
- Object of the research – The authors are writing a master thesis at BI Norwegian Business School, Nydalen, that examine the seafood cluster of Western Norway, with respect to its completeness and interactions, to analyze whether the cluster can resolve the sustainable challenges of the industry through innovations.
- Information about confidentiality and permission to quote.
- Permission to record the interview.
- Please tell us a bit about yourself (occupation, organization).

Cluster tendencies

1) Would you say that there exist mobilizations of industry actors (e.g. farming companies, research and educational institutes, suppliers) on the Western coast of Norway? (From Rogaland including Sør-Trøndelag?)
    a. Does the geographic proximity among industry players play an important role in collaborative activities and knowledge transfer?
    b. How important is the NCE clusters, SINTEF and/or other facilitators playing in these collaborative activities?
2) There has lately been an increase in study opportunities in aquaculture and seafood, including upper secondary schools, masters and MBAs.
    a. Are there any plans to further develop these current offers?
    b. Are there any plans to develop more offers in higher education in the near future?
    c. What Norwegian educational institutions do you think contribute the most to Norwegian aquaculture today?
3) In your opinion, how good is the Norwegian industry in attracting specialized labor?
    a. Where does the specialized labor come from? (from Norwegian universities or abroad?)
4) With regards to R&D and innovation focusing on aquaculture, what areas (cities) in Norway and institutions contribute the most?
    a. Does your organization cooperate with these institutions? (in other cities)
    b. Do you consider geographical expansion as beneficial? (e.g. including partners from other cities)

Sustainability

1) What do you consider to be the biggest challenges with regard to sustainability in the industry?
2) In your opinion, how does the future of the industry look with regards to these challenges?
    a. Can the challenges be solved? Will new problems occur?

Innovations

1) With respect to the development concessions, what innovation do you most believe in?

   a. Which solutions open up to sustainable farming?
2) How do you believe that such innovations will change the industry's traditional practices?

Interview Guide #2

Interview objects: Producers and researchers of/within breeding & feed

Introduction

- Introduction of interviewer(s)
- Object of the research – The authors are writing a master thesis at BI Norwegian Business School, Nydalen, that examine the seafood cluster of Western Norway, with respect to its completeness and interactions, to analyze whether the cluster can resolve the sustainable challenges of the industry through innovations.
- Information about confidentiality and permission to quote.
- Permission to record the interview.
- Please tell us a bit about yourself (occupation, organization).

Topical questions

1) How do breeding, genetics and feed production contribute to the sustainable challenges of the industry?
   a. Have there been any recent radical breakthroughs?
   b. Can these challenges be resolved through breeding, genetics and feed?
2) From where do your facility attain the most specialized workforce?
   a. Norwegian universities? Abroad?
3) How does the cooperation between your organization/ facility and partners work in practices?
   a. Who are these?
   b. What type of collaborative activities?

Interview Guide #3

Interview objects: *Farming companies*
Topic: *Innovation projects*

Introduction

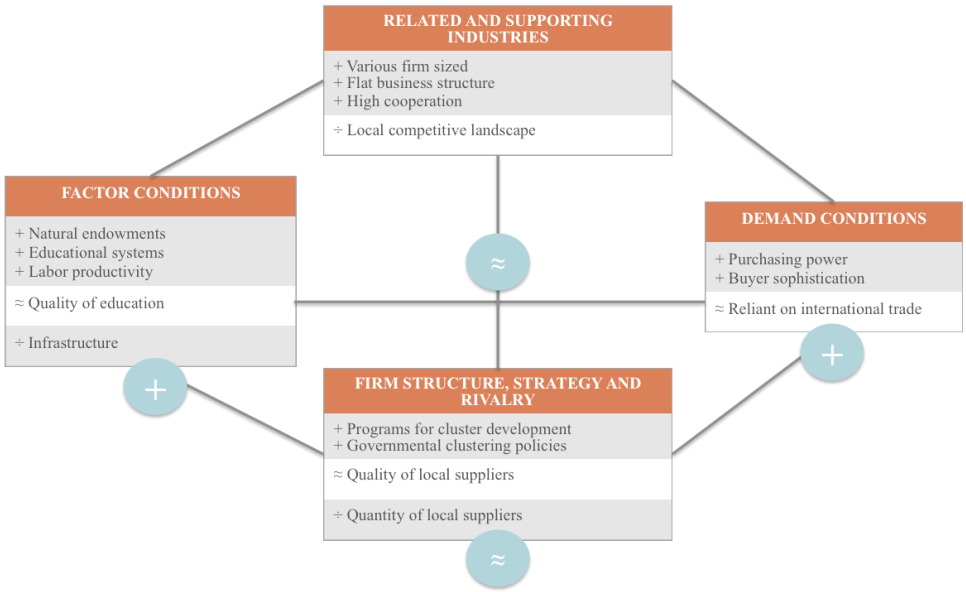
- Introduction of interviewer(s)
- Object of the research – The authors are writing a master thesis at BI Norwegian Business School, Nydalen, that examine the seafood cluster of Western Norway, with respect to its completeness and interactions, to analyze whether the cluster can resolve the sustainable challenges of the industry through innovations.
- Information about confidentiality and permission to quote.
- Permission to record the interview.
- Please tell us a bit about yourself (occupation, organization).

Topical questions

1) What is the background for your company initiating this innovation project?
2) How does this project contribute to resolving the sustainable challenges of the industry?
   a. What is the main sustainable challenge that the innovation aims to solve, in essence? (Sea lice, escapes, land use?)

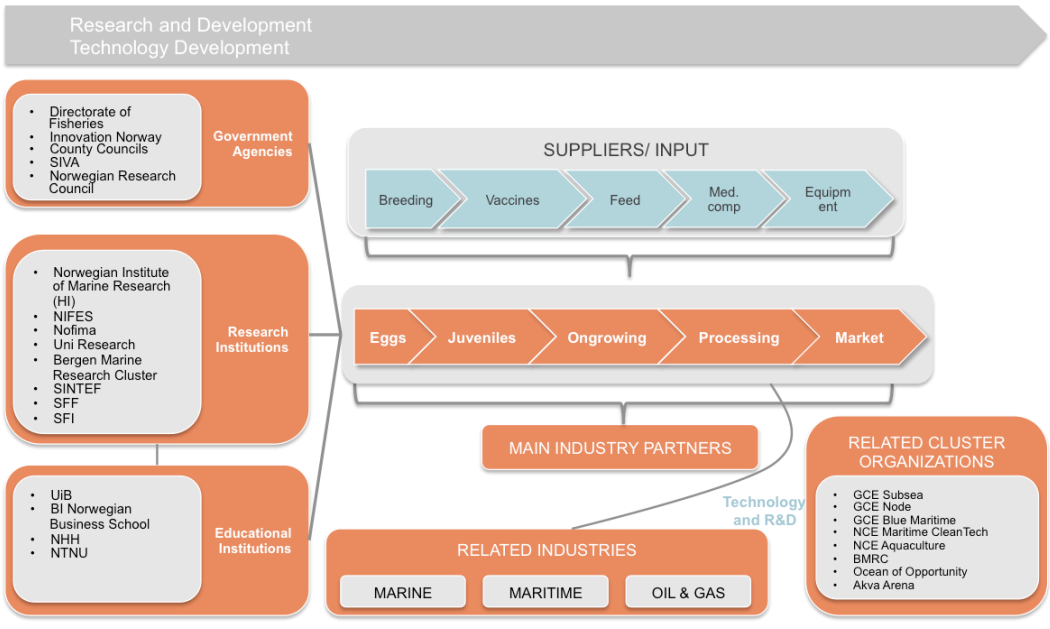
3) Would your company go through with this project disregarded the governmental development concessions?
4) Who are the main contributors in this project?
    a. Why did your company decide to collaborate with exactly these?
    b. Does the project use Norwegian actors from other industries than the seafood industry?
    c. Are there any foreign actors?
5) In your opinion, are there any actors or expertise missing in the Norwegian industry for such innovations to happen?
    a. E.g. specialized workers, suppliers, testing facilities

Exhibit 2 – Western Norway's Competitiveness



Source: Team analysis

Exhibit 3 – Linkages within the seafood cluster of Western Norway



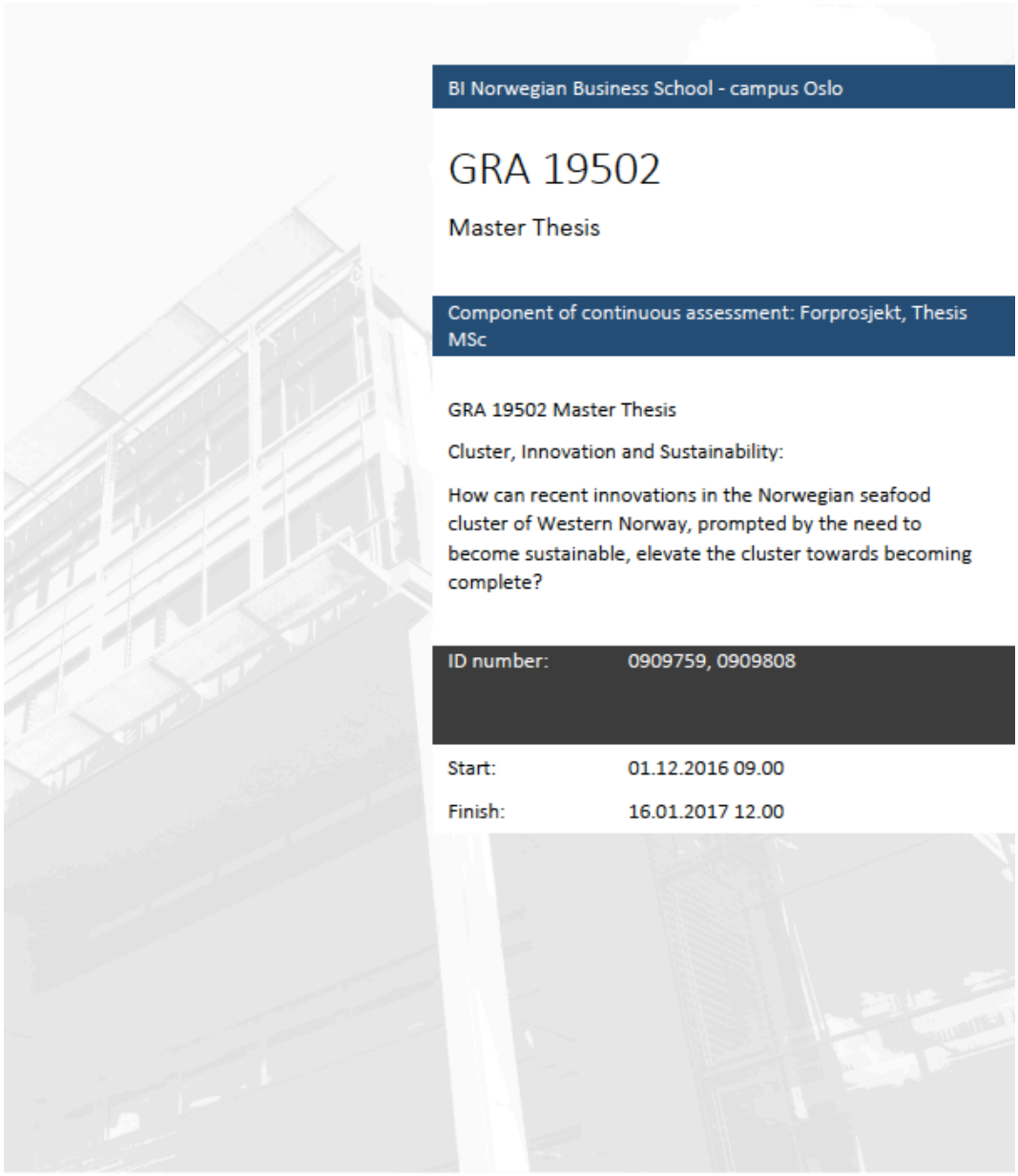
Source: Team analysis

Exhibit 4 – Key Figures Top 20 (numbers in 1.000 NOK, 2015)

FIRM	LOCATION	ACTIVITIES	TURNOVER	PROFIT MARGIN	EBIT	EBIT Margin	EMPLOYEES
Marine Harvest Norway AS	Hordaland	Breeding, eggs, farming, feed, processing, sales	12 318 672	23,55 %	3 313 817	26,90 %	2 410
Lerøy Seafood AS	Hordaland	Farming, processing, sales	11 012 360	2,39 %	266 069	2,42 %	196
EWOS AS/ Cargill	Hordaland	Feed	7 709 441	-0,89 %	96 373	1,25 %	252
SalMar ASA	Sør-Trøndelag	Farming, processing, sales	7 366 134	19,60 %	1 765 256	23,96 %	36
Skretting	Rogaland	Feed	5 984 871	4,11 %	345 883	5,78 %	297
Grieg Seafood ASA	Hordaland	Farming, processing, sales	4 693 791	1,73 %	294 520	6,27 %	24
Norway Royal Salmon ASA	Sør-Trøndelag	Farming, processing, sales	3 210 548	7,76 %	302 762	9,43 %	42
Bremnes Seashore AS	Hordaland	Farming, processing, sales	1 589 255	6,40 %	167 165	10,52 %	298
Sjøtroll Havbruk AS	Hordaland	Farming, processing, sales	1 236 943	2,55 %	100 913		324
Alsaker AS	Hordaland	Farming, processing, sales	1 165 610	16,67 %	270 951	23,25 %	28
Hordafôr	Hordaland	Feed	666 712	15,40 %	124 813	18,72 %	58
Firda Seafood Group AS	Sogn og Fjordane	Farming, processing, sales	579 455	17,64 %	131 777	22,74 %	3
Måsøval Fiskeoppdrett AS	Sør-Trøndelag	Farming, processing, sales	500 856	23,99 %	130 657	26,09 %	81
Lingalaks AS	Hordaland	Farming, processing, sales	477 005	21,06 %	121 542	25,48 %	51
Aqua Gen AS	Sør-Trøndelag	Breeding, eggs	319 305	6,92 %	125 615	39,34 %	17
Scanbio Ingredients AS	Sør-Trøndelag	Feed	218 938	-14,30 %	-3 262	-1,49 %	62
Abyss Aqua AS	Møre og Romsdal	Equipment	105 846	7,09 %	9 860	9,32 %	85
SalmoBreed	Hordaland	Breeding, eggs, vaccines, medical comp.	84 271	-2,55 %	-2 004	-2,38 %	37
First Process AS	Møre og Romsdal	Equipment	72 490	6,81 %	5 268	7,27 %	12
Lerow AS	Sør-Trøndelag	Equipment	56 126	14,71 %	10 001	17,82 %	65

Source: Purehelp AS (2017)

Exhibit 5 – Preliminary Master Thesis (GRA 19502)



BI Norwegian Business School - campus Oslo

GRA 19502

Master Thesis

Component of continuous assessment: Forprosjekt, Thesis MSc

GRA 19502 Master Thesis

Cluster, Innovation and Sustainability:

How can recent innovations in the Norwegian seafood cluster of Western Norway, prompted by the need to become sustainable, elevate the cluster towards becoming complete?

ID number:	0909759, 0909808
Start:	01.12.2016 09.00
Finish:	16.01.2017 12.00

Table of Contents

ABSTRACT

Lately, increased focus on sustainability has affected Norwegian industries, not only in the form of governmental claims and organizational focus, but also in the form of incentives. For the Norwegian seafood industry, primarily clustered along Western Norway, with traditionally low status in terms of sustainability, this megatrend gives room and means for innovative solutions. For this thesis, the authors wish to explore the links between the innovations that has been brought to life in the context of sustainability, and if these innovations have repercussions that may elevate the cluster towards completeness. This thesis will present the theoretical background to illuminate the chosen theories, namely cluster theory, innovation theory and sustainability. Within cluster theory the authors use the term "complete cluster" for the purpose of describing a highly attractive and competitive cluster. Following, the research methodology will be presented, in which the authors deem the thesis of qualitative nature and will be using a case study design. Predominantly primary data will be collected through semi-structured interviews using snowball sampling.

INTRODUCTION

Clustering as a phenomenon has gained tremendous attention over the past decades, as nations seek for ways of attaining competitiveness and sustaining competitive advantage. One of the highest accredited academics within economics and strategy, Michael Porter, has been an advocate for the subject arguing that geographical proximity allows for a collaborative platform in which firms can benefit from each other's strengths and expertise. When collaborating with universities and research institutions, the surrounding firm's performance may increase and subsequently the competitiveness of the region (Porter, 2000). Furthermore, this collaboration between firms, educational institutions and research facilities are at the core of the innovation process, which advances a cluster towards becoming complete.

Our fascination with clusters sparked an interest to further investigate an industry in Norway which may be of great importance to us in the future, namely the seafood industry. Considering the current state of the Norwegian economy, with the need to shift focus away from the oil and gas-industry and the government's newly placed emphasis on strengthening Norway as an "Ocean nation" the authors see this as a highly current research setting (Regjeringen, 2016). Within the seafood industry, the authors will concentrate on the aquaculture of salmon, which has prospered over the past decades. Our area of focus will be on the seafood industry of Western Norway, which have shown clustering tendencies due to the large concentration of both national and global players within the seafood industry. Special attention will be paid to the NCE Seafood Innovation Cluster as the cluster has members covering the entire value chain. This is a relatively newly established cluster, however it is growing at a fast pace and includes some of the world's largest salmon suppliers such as Marine Harvest and Grieg Seafood.

Furthermore, in the Norwegian setting, the concept of sustainability has become unavoidable these days. The Norwegian government has provided millions in incentives to help create sustainable "green" industries. In fact, half of Innovation Norway´s investments in 2016 were put towards "green" solutions (Regjeringen, 2016). The overwhelming focus on the "green shift" ("Det grønne skiftet") actually made it the "word of the year" in 2015 (Språkrådet, 2015). Due to the increased commitment by the government and the business world alike,

sustainability appear to be a present-day issue and interesting path for further exploration in this context.

This preliminary thesis report grounded in papers written in GRA6836 Research Methodology for Strategy and GRA6829 Strategies for Industrial Competitiveness.

RESEARCH QUESTION AND AIM

The theme of the thesis will look at the recent sustainable innovations brought forth by companies in the seafood cluster of Western Norway. The authors aim to analyze how and if innovations, spawned by sustainability, can elevate the cluster in such way that it attains the status as a 'complete cluster'. Hence, does sustainability have implications for innovative outputs? And does this positively affect the seafood cluster of Western Norway?

In the notion 'complete' the authors consider a cluster to be globally attractive, competitive, recognized and world leaders within its field. To aid our understanding of cluster completeness, Porter's Diamond Model will give us an understanding of the geographical location in focus, while Reve's Emerald will give us an in-depth analytical understanding of the linkages between the cluster members. In addition to the Emerald Model, Norwegian Innovation Clusters's definition and requirements of the status "Global Centre of Expertise" will give us a tangible understanding of the concept. The innovations that will be explored are those spawned by the increased sustainability focus, both in the efforts put forth by the government and initiatives taken by the cluster companies themselves. Throughout our thesis the authors will be led by the following research question:

> *How can recent innovations in the Norwegian seafood cluster of western Norway, prompted by the need to become sustainable, elevate the cluster towards becoming complete?*

THE RESEARCH SETTING

The Norwegian Seafood Industry

The evolution of the Norwegian seafood industry carries with it century long knowledge that has deep roots in Norwegian trading history. The basis for Norwegian fishing is the extended coastline, surrounded by relatively shallow and

fertile seas (Reve, Lensberg & Grønhaug, 1992). The history and evolution of the Norwegian aquaculture is however much shorter.

The evolution can be divided into three phases. Up until the 1970s the industry was regarded as being in the pioneer phase, and Norwegian aquaculture consisted of a small group of enthusiasts, located on the coast of Trøndeland and Hordaland. At this point, the pen cages were usually wooden with a net that kept the fish inside, which had a volume of a few thousand cubic meters (Fiskeridirektoratet, 2012). In the period between the 1970s and early 1990s, a viable aquaculture with a high level of domestic drafts and great development potential took place. At this stage, salmon in floating pen cages gave better growth, less risk and lower capital and operating costs than in land-based facilities. However, licenses were required for the establishment of new facilities, rules for localization and ownership structure suppressed growth (Norges Fiskeri- og Kysthistorie, 2011). In the transition to third phase, the aquaculture laws changes, and ownership concentration in Norwegian aquaculture has since become increasingly stronger (Reve, Lensberg & Grønhaug, 1992). The third phase marked a period of formidable growth. Despite great effort to get the commercial farming of new species, the salmonid still dominated. The growth was mainly due to productivity improvements and the industry has seen a low degree of innovation (Norges Fiskeri- og Kysthistorie, 2011).

The export of Norwegian Seafood has for the last 10 years increased, and in 2016 Norway exported seafood (fisheries and aquaculture) for 91.6 BNOK, which is approximately 23% more than in 2015. Aquaculture alone accounted for approximately 71.5% of the total exports value of Norwegian seafood in 2016 (Norwegian Seafood Council, 2016), in which salmon accounted for approximately 95% of the produced amount of farmed fish (Statistics Norway, 2015). As of 2015, the Norwegian aquaculture industry employed 5,682 men and 1,189 women (Fiskeridirektoratet, 2016, Sysselsetting).

The main players are among other Marine Harvest, Cermaq, Austevoll Seafood, SalMar, Lerøy Seafood Group, and Grieg Seafood, mainly located in Bergen, Hordaland. Lerøy and Marine Harvest have played a key role in developing market opportunities for fresh Norwegian fish, creating high demand for Norwegian seafood globally and huge export success (Region Bergen, 2016).

The value chain of the seafood industry (**Exhibit 1**) consists of six main stages that are described as; feed and ingredients, an R&D-intensive phase that

aims at finding the best ingredients to create feed; breeding and smolt, the process in which eggs are matured into smolt; harvesting, in which the fish is collected either from commercial fishing or aquaculture; processing, that can be either primary processing, in which occur activities such as cleaning, sorting, freezing, filleting and packing the seafood, and secondary processing, in which are created processed seafood products for ready-to-eat meals or meals' components; and distribution to global markets (SI Cluster application, 2015).

The Seafood Cluster of Western Norway

As Norway is considered an Ocean Nation, everything from small to large seafood companies can be found along the coast. Due to the cluster-focus of this thesis the authors see it as beneficial to disclose the geographical area that will be of main concern. As mentioned there exists an organized cluster in Bergen, the NCE Seafood Innovation Cluster, which will provide much of the necessary knowledge regarding existing innovations and cluster development. However, several large seafood companies are left out due to its geographical appraisal and because of the importance of these companies they cannot be overlooked. Hence, the geographical area will stretch from Rogaland as far as to Sør-Trøndelag, to incorporate firms such as Skretting, the world's largest fish feed producer, and Salmar, one of the world's largest salmon producers. Firstly, a description of the NCE Seafood Innovation Cluster is put forth to lay out the basis for our analysis.

Several large players in the Norwegian seafood industry are located around the Bergen region, and these companies include Marine Harvest, Lerøy Seafood Group, Grieg Seafood and Salmon Group. SalmoBreed and its associated company StofnFiskur specialize in the breeding of Atlantic salmon (SalmoBreed, 2017). Further, EWOS/Cargill is amongst the world's largest suppliers of feed and nutrition for farmed fish (EWOS, 2017).

The close proximity of these large industry players created a platform for collaboration, which today has become the NCE Seafood Innovation Cluster (henceforth SI Cluster). The cluster dates back to 2011, when Fiskeriforum Vest (FFV) and regional development agencies started the process of formalizing cluster cooperation, supported by Innovation Norway and Hordaland County (SI Cluster, 2015). Today the cluster includes 70 partners. The total revenue of the SI Cluster's core industry partner was 57,7 BNOK in 2015, representing organizations with 15,000 professionals covering the cluster's industry

participants, centers of R&D and innovation (SI Cluster, 2016). The SI Cluster members in Hordaland are all Norwegian established companies, which today represent a mixture of big international companies and large number of medium-sized companies.

Within the cluster one can find large research institutions such as Norwegian Institute of Marine Research (IMR), Nifes, Nofima, Uni Research and Bergen Marine Research Cluster. In fact, the Bergen region has Europe's largest concentration of Marine research, and is the 13th largest Marine city in the world in terms of number of scientific publications (UiB, 2015). The SI cluster receives nearly 60% of total public investment in Marine R&D (3.2 BNOK) on a national scale (SI Cluster, 2016). Additionally, the 5 core industry partners have a R&D budget totaling 400 MNOK.

The cluster also collaborates with Norwegian School of Economics and the University of Bergen, which have since 2016 established a new MBA in Sustainable Innovation in Global Seafood and an integrated Masters program in Civil Engineering in seafood science. These programs have been established due to initiatives taken by the cluster members (SI Cluster, 2016).

The cluster received its "Norwegian Center of Expertise" (NCE) status in 2015, after an unsuccessful attempt to obtain the status as a "Global Center of Expertise" (GCE). This was awarded by the Norwegian Innovation Cluster-program, which is owned in cooperation between Innovation Norway, SIVA and The Research Council (Forskningsrådet). The program is organized in order to strengthen each clusters' attractiveness and innovativeness and received 137 MNOK in 2015 in financing from the Norwegian Government (Norwegian Innovation Clusters, 2015). Currently there are 14 Norwegian clusters in the NCE program, and only three has been accredited the GCE program. The GCE program requires the cluster to have a global position and have growth potential to become world leaders within their field. Further, the Government have appointed the Marine sector as one of six prioritized areas in their "long term plan for research and higher education" and have since 2013 increased the budget for Marine research by 110 MNOK (Regjeringen, 2015). A new ocean strategy is being developed, and will be presented during the first half of 2017. The governmental support is critical for the industry to prosper and enables the cluster to advance its research and development towards more innovative solutions.

Despite that the cluster seems to cover all areas of the value chain, numerous companies which are important in the seafood industry are not members. Salmar, for example, located at Frøya in Sør-Trøndelag, is a large contender towards becoming the world's largest salmon supplier. The company has recently commenced a project becoming pioneers within ocean farming as they are now creating the world's first offshore fish farm. Ocean Farming has received grants from Innovation Norway in the project's early stages. This project may, if successful, lead to a solution to the environmental challenge of land use and contribute to furthering sustainable growth for the seafood industry (Salmar, 2017).

With regards to research institutions, SINTEF, located in Trondheim in Sør-Trøndelag, is Scandinavia's largest independent research organisation. As of the 1st of January 2017, SINTEF Ocean AS became operative, where three institutes have merged together, becoming the next largest research institute at SINTEF with over 340 employees and an annual turnover of around 500 MNOK (SINTEF, 2017).

Further south in Norway one can find Skretting, the world's largest feed producer, which sold fish feed for around 5.9 BNOK in 2015. The firm has operations in 18 countries worldwide and is dedicated to operate sustainable through its Sustainable Economic Aquafeeds (SEA) program (Skretting, 2017). Due to its location, in Stavanger, the company has not gained access to the NCE Seafood Innovation Cluster, which one might question due to the potential advantages of collaboration with this large feed company.

Given that there are firms clearly succeeding in the industry and competing on an international scale, the authors wish to use the term cluster more freely and not confine it to an organized cluster within a small area, such as the NCE Seafood Innovation Cluster but to elevate our vision to incorporate other companies which will prove important for the development of a complete seafood cluster in Norway.

THEORETICAL FOUNDATION

In this section, the authors will aim to present and discuss the literature supporting the research question and objectives. The thesis will be based on theoretical foundations presented within the field of strategic management, where the main theory will be based on cluster participation and how the companies involved can

benefit and contribute to enhanced competitiveness of the industry through innovative measures triggered by sustainability.

Cluster Theory

Clusters have been a part of economic theories for centuries, with geographic concentrations of trades and companies. However, the study of clusters has become increasingly important as of recent years, in fact the number of articles published on the topic has quintupled between 1980 and 2000 (Maskell and Kebir, 2005). The most well known examples of clusters in the world today are Silicon Valley and Hollywood.

Most of the work on clustering stems from two disciplines: neoclassical economics and the social and institutional tradition. The concept was first introduced in 1890 by Alfred Marshall in his paper 'Principles of Economics', but not heavily researched until the and 1990s, when Michael Porter published his 855-page study 'Competitive Advantages of Nations' (Cortright, 2006). Here, Porter puts forward a microeconomical theory of national competitiveness in the global economy, where clusters play a prominent role. Porter (2000, p. 15) defines clusters as "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also cooperate". In his book, 'On Competition' (2008), Porter argues that economies should be viewed as clusters, rather than companies, industries or sectors, as the cluster align better with the nature and foundation of competitive advantage. "Clusters … capture important linkages, complementarities, and spillover effects of technology, skills, information, marketing and customer needs that cut across firms and industries." (Porter, 2008, p. 221) The term cluster has been defined in numerous ways due to its widely different uses and this has caused some confusion. Authors mostly agree on the overall idea, which is accredited Porter, however they may disagree on its application to a particular industry or region (Cortright, 2006).

According to Porter (2008) clusters can affect competition in three ways: (1) increasing the productivity of cluster members; (2) increasing capacity for innovation and productivity growth; and (3) replicate new business formation that can carry the innovation and grow the cluster. In this way, a cluster can be

described as a system of organizations and institutions whose value as a whole is greater than the sum of it.

Considering the economic and technological implication of clusters, there are two views in which clusters can affect national, state and regional growth. Some cluster theorists have emphasized the external and industrial resource conditions, and argue that superior industrial resources and social networks that gives access to 'cutting-edge information' is the key to cluster growth. Alternatively, cluster theorists have emphasized the internal and technological dynamisms (Zhang et al., 2009). The latter view resulted from Saxenian's (1994) observations of the Silicon Valley region that outperformed other clusters based on their flexible and technological dynamisms that promoted collective learning for several firms. This preliminary thesis report will focus on the technological dynamisms view on cluster, in accordance with the attributes of the selected cluster.

Complete Cluster

According to Porter (2008) a cluster must move towards attaining competitive advantages, and "… competitiveness depends of the capacity of its industry to innovate and upgrade. Companies gain advantage against the world's best competitors because of pressure and challenges. They benefit from having strong domestic rivals, aggressive home-based suppliers, and demanding local customers." (Porter, 2008, p. 155) In 'The Competitive Advantage of Nations', Porter puts forth the Diamond model, which explain why a nation or location achieves success and competitiveness, and are capable of consistent innovation, in a particular industry.

The attributes of the location, or cluster, must have preferable factor conditions, demand conditions, supporting industries and firm strategy, structure and rivalry (Porter, 1980)(**Exhibit 2**). This model will be utilized to provide a fundamental understanding of the location's competitiveness, as clusters located in a region with non-preferable conditions simply cannot achieve competitiveness.

Critique of 'The Competitive Advantage of Nations' has emerged through confusion regarding a cluster's geographic limitations, saying that the concept is too vague and research has resulted in differing results (Cortright, 2006). Moreover, it seems slightly counterintuitive that an important factor of clustering is geographically proximity; given the technological advances in the world today,

and the fact that globalization has opened the doors for worldwide collaboration between firms. Further, Cooke (2012) criticizes Porter for deficient applicability in modern context, as the intentional grouping of businesses creates homogeneous communities of specialists with little knowledge generation.

Another addition to explaining the complexity of clusters is Reve's concept of the 'Global Knowledge Hubs' (Reve, 2011). Reve distinguishes between industrial clusters, knowledge hubs and global knowledge hubs that ultimately are different ways of understanding and explaining industry models that inhibit different degrees of attractiveness. As the clusters become more and more knowledge intensive and global, they move up towards becoming a global knowledge hub (Reve, 2011). The global knowledge hubs have the highest degree of attractiveness, and are characterized by innovation and knowledge related driving forces. These clusters possess a unique combination of the most advanced and knowledge-intensive companies, the leading research and development institutes and the most competent owners.

Whether a cluster represents a global knowledge hub can be analyzed and mapped through the cluster's commercial attractiveness, which can be defined along six dimensions: (1) cluster attractiveness; (2) educational attractiveness; (3) talent attractiveness; (4) ownership attractiveness; (5) environmental attractiveness; and (6) R&D and innovation-attractiveness.

Further, the Norwegian government also sees the value in cluster development and has their own way of categorizing and evaluating the competitiveness and attractiveness of clusters. On the 7th of January 2014, the Norwegian ministry of economics announced that Innovation Norway, The Research Council of Norway and SIVA would implement a new program for development of industrial clusters as an addition to the Norwegian Innovation Clusters (**Exhibit 3**), previously comprised of "Arena" and "Norwegian Centres of Expertise" (NCE). The third and new level was given the name of "Global Centres of Expertise" (GCE)(Nærings- og Fiskeridepartementet, 2014). The GCE level is aimed towards maturing clusters that already have a systematic cooperation in strategic areas, both within the cluster, but also internationally with research and development institutions and other relevant parties. The firms in the cluster must be a part of a global value chain, and the cluster should be characterized by significant potential growth, in both domestic and international markets. Within their respective sectors and technology areas, the clusters attain a

global position. Norwegian Innovation Clusters are currently focusing on four goals for the cluster programs: (1) increased innovation; (2) targeted internationalization; (3) strengthened cluster attractiveness, and; (4) access to tailored expertise (GCE, 2015). There are currently three global centers of expertise in Norway; GCE Blue Maritime, GCE Subsea, and GCE Node (GCE, 2017).

Although the concept of clustering including its benefits and aspirations are highly discussed, less literature defines what a complete cluster is. Based on the Diamond and Emerald model, a cluster should strive to become as competitive and attractive as possible. When applying these models to the case in question, a more clear understanding should prevail regarding the cluster´s road towards completeness. Additionally, the requirements of attaining a certain cluster status in Norway, controlled by governmental organizations can provide a picture of what is needed to elevate the cluster to a higher status. Hence, when considering whether a cluster has attained a competitiveness and attractiveness on the level of a "complete cluster", the Diamond model, Emerald model and the requirements of a 'Global Center of Expertise' will be analyzed.

Innovation

It has become collectively accepted that innovations are regarded as major means through which not only companies, but also countries can gain and sustain competitive advantages in international competitive marketplaces (Piperopoulos, 2012). Innovation is, according to Porter (1990), broadly defined as "improvements in technology and better methods or ways of doing things," and includes, among others, product and process changes, new approaches to marketing, new forms of distribution, and new outsets of scopes. Innovators do not only respond to possibilities of change, but also force it to proceed faster. Nevertheless, innovation always includes investment in expanding skills and knowledge.

Porter (1990) emphasizes how innovation contributes to a nation's or location's competitive advantage. The most distinctive causes of innovation that affect competitive advantage are (1) new technologies; (2) shifting buyer needs; (3) emergence of a new industry segment; (4) shifting availability, and; (5) changes in government regulations (Porter, 1990). According to modern innovation theory, alliances of firms, interaction, and exchanges among

organizations, research institutes, universities, and other institutions, are at the core of the innovation process. Innovation is a dynamic social process that evolves most successfully in a network in which intensive interaction takes place between those "producing" and those "using" knowledge (Roelandt & Hertog, 1999).

The advantages that cluster participation brings forth in innovation compared to doing innovation in isolation are many. First and foremost, cluster members are able to more clearly and rapidly perceive new buyer needs, as a result from the different buyer knowledge relationships among the cluster members (Porter, 2000). Second, cluster members can be exposed to greater insights of new technological, operating and delivery possibilities though the linkages and relationships within the cluster, through for example direct observation of other cluster members (Porter, 2008). Third, firms within a cluster are able to more rapidly source new components, machinery and other elements necessary to implement innovations through for example local suppliers that also take part in the cluster (Porter, 2008). Then there is the advantage of lower transaction costs due to the geographic proximity and relationships among the organizations of the cluster. Facilitation of these advantages is the competitive environment and peer pressure, and constant comparison occurring among the cluster members. Similarity of microeconomic industrial environment and circumstances combined with the existence of several rivals, forces cluster members to distinguish themselves, creating a fruitful avenue for innovation (Porter, 2008).

Under specific conditions, however, cluster participation can hinder innovation (Porter, 2000). This is a result of the cluster members developing a uniform way of competing. This creates homogeneity that supports old behaviors, restrain new ideas, and creates stringencies that hinder adoption of improvements (Porter, 2008).

A modern way of thinking about innovation processes is through the concept of 'innovation systems'. The concept argues that innovations do not emerge in isolation within one firm, but stems from interaction by a number of entities, actors and agents (Piperopoulos, 2012). Lundvall (1992) characterizes the span of innovation systems to include organizations and institutions collaborating in 'searching' and 'exploring'. He later put forth a broader definition of an innovation system to include the following; "all parts and aspects of the economic structure and the institutional set up affecting learning as well as searching and

exploring – the production system, the marketing system and the system of finance present themselves as a sub-system in which learning takes place. Determining in detail which sub-system and social institutions should be included, or excluded, in the analysis of the system is a task involving historical analysis as well as theoretical considerations." (Lundvall, 2010, p. 13)

It hence becomes clear that in order to study innovation within a cluster, which is the aim in the context of this thesis, several different components and aspects of economic and social environment that influence, directly or indirectly, needs to be looked at.

Sustainability

The term sustainability has been defined numerous times, and is often seen as somewhat vague. One of the first definitions of sustainability was coined by the World Commission on Environment and Development (1987) which defined it as "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (The world Commission, 1987). The definition by the World Commission is clearly very broad and not tangible enough for businesses to incorporate into their daily operations. Thus authors such as Kemp, Porto and Gibson (2005) and Scott (2013) began to develop studies aiming to provide a clearer picture of how to govern the business in a more sustainable and "green" way.

In order to operationalize the term, Elkington (1999) introduced a framework which today has become one of the most important models for future sustainability theory (**Exhibit 4**). It broadens the concept, and argues that a business needs to focus on three performances in order to become sustainable. The model is referred to as the "Triple Bottom Line" and incorporates Economic performance, Environmental performance and Social performance. According to Elkington, social and environmental performance have to be integrated and considered together with economic performance, to see how they add, or potentially destroy value.

Carter and Rogers (2008) added four new dimensions to Elkington's framework, and considered the intersections of the three original concepts and where the optimal combination is found (**Exhibit 5**). The intersection between economic performance and environmental performance, and economic performance and social performance is seen as "better" than where social and

environmental performance intersects. Thus implying that economic performance should be the main focus to an organization.

Sustainability is a huge trend today, both in the business world, and the broader public society. Despite this new focus on sustainability authors still question whether businesses adopt sustainability by own will or solely because they feel obliged to do so (van Marrewijk, 2003). Despite large volumes of criticism in the literature regarding the positive gains to a business from investing in sustainability and complying with regulations (stemming from environmental policy makers or governments), Porter and Linde (1995) has entered the discussion and has pointed to numerous examples of businesses gaining from adapting to sustainability. They have challenged the traditional mind-set of considering sustainability in terms of environmental regulations as something negative viz. increasing costs to a company. The authors points to these environmental regulations as possible triggers to innovation, and that these innovations may offset the costs of these necessary changes. Authors such as Hazilla and Kopp (1990) and Gray (1987) have a different view however, and largely focus on the costs assuming no innovation, i.e no benefits. Jorgenson and Wilcoxen (1990) have also left the benefits out of the equation, creating solely a negative outlook on the view of environmental regulation. There are obviously examples where innovation does not occur, and if it occurs, that the costs exceed the gains. However, the question that prevails is; would these types of innovations emerge if no pressure to change exists?

Throughout the article “Toward a New Conception of the Environment-Competitiveness Relationship” Porter and Linde (1995) exemplifies cases where regulations on pollution, CO2 and water purification has led to significant innovations allowing for economic gain. One example is The Robbins Company's jewelry-plating system. In moving to a closed-loop system which purified and recycled water, Robbins achieved a savings of over $115,000 per year and reduced water usage from 500,000 gallons to 500 gallons per week. The capital cost of the new system, which completely eliminated the waste, was $220,000, compared to about $500,000 for a wastewater treatment facility that would have brought Robbins' discharge into compliance only with current regulations (Porter and Linde, 1995).

Another example is seen at Dow Chemicals when federal and state regulations required them to close particular evaporation ponds used for storing

and evaporating wastewater resulting from scrubbing hydrochloric gas with caustic soda. The company redesigned its whole production process and was able to eliminate the need for evaporation ponds, reduce its use of caustic soda, and capture a portion of the waste stream for reuse as a raw material in other parts of the plant. It reduced caustic waste by 6,000 tons per year, for a savings of $2.4 million per year. The entire process only cost $250,000 to implement (Dorfman, Muir and Miller, 1992).

Clearly the trend for sustainability has created a necessity for companies to conform to new regulations and the changes in the environment. As seen in these examples there may be benefits from complying with environmental regulations and taking an active part in becoming sustainable. The article goes as far as to say that these pressures, which trigger innovations, may ultimately lead to competitiveness. This thus provides an interesting background for our further research on this thesis.

Preliminary Framework

In the forthcoming thesis the authors wish to see if there is a link between the innovations that has been brought to life in the context of sustainability, and if these innovations have repercussions that may elevate the cluster towards completeness. The authors will view recent innovations, as for example the offshore fish farming project introduced by Salmar, and analyse whether this type of activity may affect the levels, or dimensions, of attractiveness presented in the Emerald model. More specifically, can this type of innovation affect the R&D & Innovation attractiveness? At first glance this may be the only element that will be affected by the innovation-activity. What the authors hope to understand is if there might be repercussion by this potential increase in R&D & Innovation attractiveness which leads to increases in the other dimensions.

From a previous paper conducted in the course GRA6829 Strategies for Industrial Competitiveness the authors found that Talent attractiveness, Educational attractiveness and Environmental attractiveness were the areas which could be improved in the case of the NCE Seafood Innovation Cluster. The cluster itself has also pointed to similar areas in their status report from 2016 stating three strategic pillars to strengthen the cluster/industry, which include talent development, sustainable innovation and supplier development (SI cluster; status report, 2016). Using the Emerald model and the knowledge the authors are

expecting to gain from Norwegian Innovation Clusters the authors wish to ultimately explore the following propositions:

- Increased focus on sustainability triggers innovations in the seafood cluster in question.
- Recent innovations in the seafood cluster lead to higher R&D and Innovation attractiveness.

If the above-mentioned proposition is true then the following sub-propositions transpire;

- Increased R&D and Innovation attractiveness caused by recent innovations lead to increase environmental attractiveness
- Increased R&D and Innovation attractiveness caused by recent innovations lead to increase in talent attractiveness
- Increased R&D and Innovation attractiveness caused by recent innovations lead to increase in educational attractiveness

Lastly,

- These recent innovations has (now or in the near future) an affect on the cluster in terms of becoming a Global Centre of Expertise.

RESEARCH METHODOLOGY

This section of the paper is devoted to the description and justification of appropriate design and methods for this preliminary thesis report. This represents the plan of conduct and feasibility of the study, as well as highlighting the preservation along with flexibility of the qualitative method, as this is often regarded as challenging. In respect to the proposed research question of this report, the overall characteristics of our research is regarded as a qualitative. This is because the qualitative research method will give us some form of explanation, understanding and interpretation of the case study, in addition to the methodology being a flexible one. This section is roughly based on a paper the authors wrote in GRA6836.

Research Design

As research methods are normally associated with different kinds of research design, the authors must opt for a design framework that enables us to build good research within the context of determined research question (Bryman & Bell, 2015). Given the complexity of operationalizing clustering, innovation and

sustainability in measurable quantitative variables, the authors are inclined to use a qualitative approach.

Bryman and Bell describe five different research designs suitable for the qualitative approach: experimental-, cross-sectional-, longitudinal-, case study- and comparative design. Given the reliability, replication, and validity that are necessary to carry out determined research question for this thesis properly, the *case study design* stands out. According to Eisenhardt and Graebner (2007), the case study approach is widely used within business studies. The choice fell upon the case study design based on a process of elimination. The chosen study will be of one single case, the Norwegian seafood cluster of Western Norway, at a single point in time, with primary qualitative data. Further, the case study design allows for the necessary focus and in-depth elucidation on the mechanisms and systems within the location and functional parts of the seafood cluster of Western Norway. Overall, the case study design allows the authors to have the aptitude to clarify why and how things happen, which will be essential for this thesis.

Lastly, Yin (1993) describes three approaches to case studies: exploratory, explanatory and descriptive. The way in which the research question is formulated should determine the choice among these (Saunders et al, 2009). Given that the authors wish to clarify and elucidate how sustainability affects innovation in our cluster, and how these dynamics further evolves the seafood cluster of Western Norway, the authors consider this to be an explanatory study in essence. The explanatory case study design allows us test and explore the theoretical topics of interest in the chosen context. It further allows the authors to explain the possible causal relationship between an independent variable (sustainability) and a dependent variable (innovation), and how this affects the mechanisms within a cluster in which it elevates into becoming complete.

Sampling

Purposeful sampling in the context of qualitative research is crucial, as it deals with recognizing and selecting individuals that are knowledgeable and experienced with the specific topics and objects of interest (Palinkas et al., 2013). Business research distinguishes between the probability and non-probability sampling, which refers to the sampling being randomly selected or not (Saunders et al, 2009). In our case, the authors will apply *the non-probability sampling technique*, using the so-called *Snowball sampling* (Bryman & Bell, 2015).

Applying the *non-probability sampling technique* in the case of this thesis means that the authors aim to interview and talk to people that is knowledgeable about the sustainable and innovative activities within the seafood industry, as well as the collaborative mechanisms that takes place within the geographical location of Western Norway. A purposeful sampling in this case would, for example, be the NCE Seafood Innovation Clusters, and executives of firms within the seafood industry residing in Western Norway. The disadvantage with applying the non-probability sampling technique is, however, that a priori data collection the authors relies on mapping, contacting, and get access to the specific samples, or interview subjects, that would be adequate to include in the sampling "portfolio".

However, applying the *snowball sampling technique* deals with the disadvantage of the non-probability sampling technique. In such case, the initial study subjects are able to recruit or refer to future study subjects that can be included in the sampling "portfolio" (Bryman & Bell, 2015). In the context of this thesis, executives of firms within the seafood industry of Western Norway, for example, is able to refer and recommend other knowledgeable individuals that could be of value. By applying the snowball sampling technique the authors are able to maintain a flexible data collection and sampling, by opening up for interviews with cluster member introduced by our initial contacts.

Contact and access has already been established with the NCE Seafood Innovation Cluster in Bergen and Norwegian Innovation Clusters in Oslo (Innovation Norway), whom has agreed to initiate contact on the author's behalf with relevant parties for this thesis. A purposeful sampling would hence be to use the NCE Seafood Innovation Cluster in Bergen as a starting point to further build up and attaining new contacts for data collection. The study subjects referred and recommended by the NCE Seafood Innovation Cluster are also further a gateway for attaining new and purposeful sampling. Lastly, the authors will attend the North Atlantic Seafood Forum conference, which takes place in Bergen from 7th to 9th of March. This will be an opportunity to upscale our sampling "portfolio".

Data Collection

Data collection is the key point in the research, where data is collected in order to answer the research question (Bryman & Bell, 2015). The data collection in this case is divided into primary and secondary data.

Primary Data

When choosing a primary data collection method, the research question and the nature of the topics of interest will be considered. In order to get an in-depth understanding and be flexible when exploring the dynamics between sustainability and innovation in the seafood industry, and how this affect the evolution and maturity of the seafood cluster of Western Norway, *semi-structured interviews* will be applied as the main data collection method.

A semi-structured interview is an interview where the researcher is guided by a list of questions, which is specific to the topics of choice for the research (Bryman & Bell, 2015). The authors aim is to use different interview guides on different participants based on their occupation and activities within the cluster. First, Bjørn Arne Skogstad, Program Leader in NCE and GCE in Innovation Norway, will be interviewed regarding Innovation Norway's requirements of the different levels of clustering in Norway and the status of "Global Centre of Expertise". Then an interview with Tanja Hoel, Managing Director in NCE Seafood Innovation Cluster, will be conducted. **Exhibit 6** shows a rough indication of different interview guides that will be carried out for different parties in different contexts. Final semi-structured interviews will be carried out in accordance with Bryman and Bell's (2015) recommendations (**Exhibit 7**). The questions in the interview guides are highly guided by the topics of interest and our predictions of pattern leading to cluster maturity as a result of innovation, facilitated by sustainability.

Secondary Data

Although interviews will be the primary source of data, the authors will also rely on material collected by others. Secondary data sources will be utilized to provide in-depth understanding of the case and as a complementary source to verify that our obtained data does not deviate exceedingly from prevailing knowledge (Saunders et al., 2009). In relation to this case study, the most important secondary data will be gathered from NCE Seafood Innovation Cluster, Innovation Norway, and other public documents. For the methodological and theoretical part of the literature, we have used academic journals and books.

Secondary data sources bear numerous advantages such as cost- and time efficiency, high-quality data and "pre-analyzed" material (Bryman & Bell, 2015). Limitations is connected to data complexity, absence of key variables, and self-bias. Hence, data collected from samples will be analyzed with a critical lens.

Qualitative Analysis

According to Saunders et al. (2009), the previous sections justify our approach and methodology as qualitative. The qualitative data analysis is the range of procedures and processes, which will give us some form of explanation, understanding interpretation of the case we are studying.

The two commonly used strategies for analyzing the qualitative data are analytic induction and grounded theory (Bryman & Bell, 2015). As the authors aim to elucidate chosen theories in the context of the seafood cluster of Western Norway, and view recent innovations and analyze whether these activities may affect the attractiveness of the cluster, the authors will use the grounded theory method to analyze data. Grounded theory is defined as "*theory that was derived from data, systematically gathered and analyzed through the research method. In this method, data collection, analysis, and eventually theory stand in close relationship to each other.*" (Strauss and Corbin, 1998)

PROJECT ORGANIZATION

Tentative Plan

Marshall and Rossman (2011) emphasize that the two essential points for successful completion is to work out a timetable and find out what kind of resources are at our disposal (Bryman & Bell, 2015). In the case of this project work, the group consists of just two people; hence overview and control will not be a problem. Further the authors acknowledge that there may be need for changes and wish to embark on this project with flexibility in mind. The authors identify three main areas of the project, (1) literary writing and understanding; (2) data collection, and; (3) data analysis. Both Student #1 and Student #2 will have equal responsibility for the main areas for ensure proper completion. A tentative timeline is needed as it allows us to follow a structured plan with deadlines for the different tasks. Our timeline gives us an overview of our timetable and key tasks which provides an impression of how much time the authors can spend on each task and which tasks that will overlap each other (Bryman and Bell, 2015).

Tentative Thesis Disposition

The research analysis of the tentative master thesis aims to elucidate cluster and innovation theory in the context of the seafood cluster of Western Norway, and view recent innovations and analyze whether these activities may affect the attractiveness of the cluster. Here, the gathered data collection will be analyzed through frameworks such as the Emerald Model and Diamond Model, as well as Norwegian Innovation Cluster's definition and requirements of a 'Global Centre of Expertise'. Concluding, the tentative master thesis will include affirmative or dissenting comments to the given propositions, and imply strategic initiatives for the seafood cluster of Western Norway in the pursuit of becoming a complete cluster. **Exhibit 8** illustrates the tentative thesis disposition of the thesis.

CHALLENGES AND LIMITATIONS

With regards to the type of study that will be conducted there are several considerations. The interview schedule as of now is not complete, and there may be issues concerned with the availability of important cluster members. The interviews will be conducted in Bergen, and as the authors are situated in Oslo, the trip to Bergen will be predetermined and for a limited amount of time. The authors must thus prepare for the possibility of unavailability of important people. Additionally, our interviewees may be subject to bias, as they might not disclose information, which may be negative for their company or the cluster. Further, time is also an important consideration, as the authors have a time limit and working with snowball sampling may imply that information is received later than initially planned, causing delays in the time schedule.

Further, challenges with regards to the analysis may be the difficulty of determining the effect these innovations will have, as they are currently in the stages of development. Arguments of effect will be based on the views of the individuals being interviewed, and based on the author's evaluation after gaining this information. There might be conflicting views regarding the future of the cluster, which the authors must be prepared for. Additionally, the authors understand that the thesis may conclude with that there are no visible effects, or that respondents (particularly Norway Innovation Clusters) do not view these innovations as significant enough to alter its view of the cluster. Additionally with regards to our analysis, the way in which the term 'complete' is defined by the authors, using the Diamond- and Emerald model and the Norwegian Innovation

Clusters' definitions may be flawed and will solely prove to be sufficient once the data collected is analyzed and discussed.

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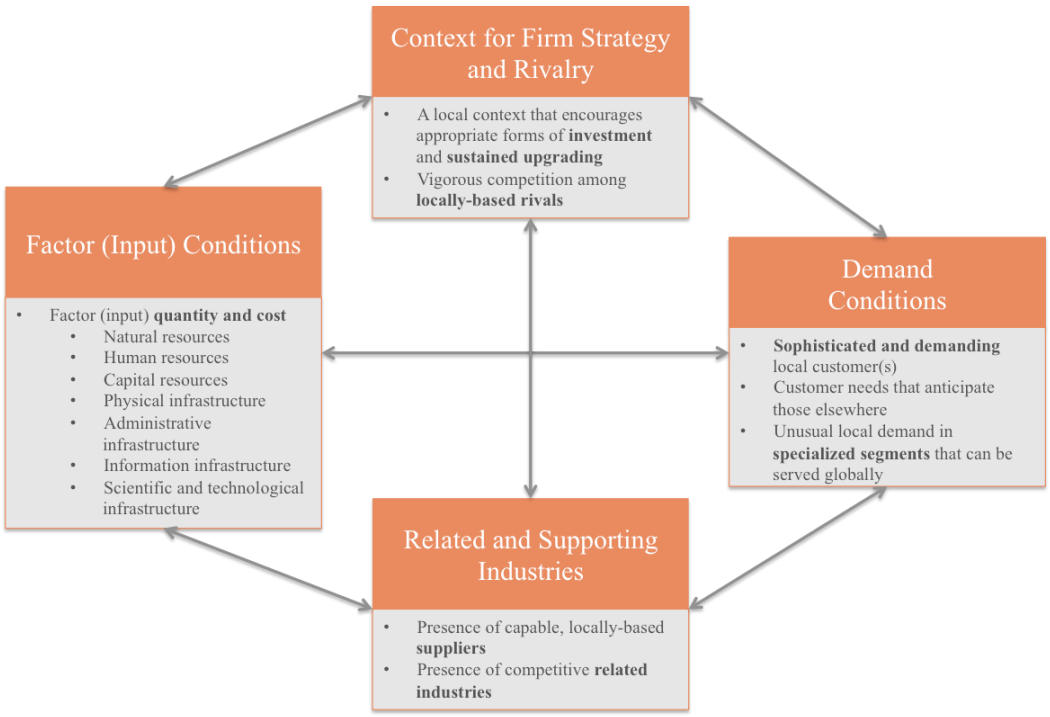
EXHIBITS

Exhibit 1 – The Seafood Industry Value Chain

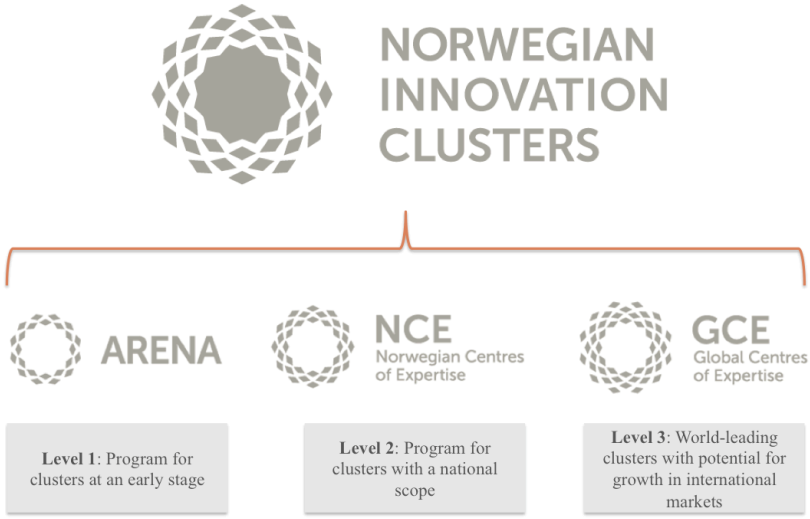
Source: Adopted from NCE Seafood Innovation Cluster, 2015, April

Exhibit 2 – The Diamond Model, Sources of Locational Competitive Advantage



Source: Adopted from Porter, 2008, p. 211

Exhibit 3 – The Norwegian Innovation Clusters Program

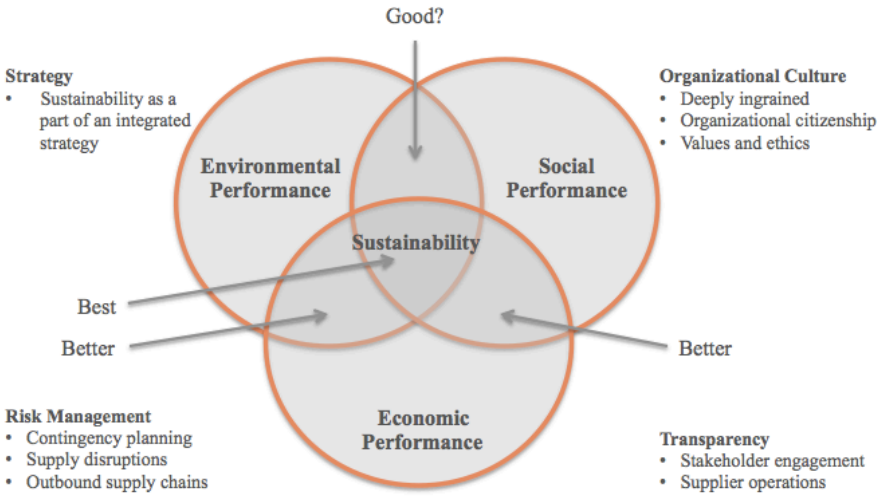


Source: Adopted from Innovation Norway, 2017, "Klynger og bedriftsnettverk"

Exhibit 4 – The Triple Bottom Line

Source: Adapted from Elkington, 1999

Exhibit 5 – The Sustainable Supply Chain



Source: Adapted from Carter & Rogers, 2008

Exhibit 6 – Interview Guides

Program Leader NCE and GCE, Innovation Norway, Bjørn Arne Skogstad (45 min.)
Introduction
1) *Introduction of interviewer(s)* 2) *Object of the Research* – Provide information sheet 3) *Information about confidentiality* - Provide consent form 4) *Permission to record the interview* 5) *Please tell us a bit about yourself*: a) Occupation b) Years within the organization c) Description of the organization you are presenting
Questions
1) What is the main purpose behind the Norwegian Innovation Clusters program? 2) How do you consider a cluster when applying for an Arena, NCE or GCE status? a) Are there any specific theoretical foundations you use? 3) What are the specific requirements that need to be fulfilled in order to become a GCE? 4) What were the considerations when you turned down the Seafood Innovation Cluster of Bergen for a GCE status? a) What does it need in order to achieve a GCE status? 5) Do you believe that innovation growth will evolve the Norwegian Seafood Industry? 6) Do you believe that higher sustainability will evolve the Norwegian Seafood Industry?
Ending
1) Summary 2) Is there anything you would like to add? 3) Is there anyone within your company, that would make a contribution to this research?

Managing Director, NCE Seafood Innovation Cluster, Tanja Hoel (45 min.)
Introduction
1) *Introduction of interviewer(s)* 2) *Object of the Research* – Provide information sheet 3) *Information about confidentiality* – Provide consent form 4) *Permission to record the interview* 5) *Please tell us a bit about yourself*: a) Occupation b) Years within the organization c) Description of the organization you are presenting
Questions
1) The main goal of the NCE Seafood Innovation Cluster is to foster sustainable growth for the Norwegian seafood Industry by reinforcing cooperation between business, R&D, and education. → How does the cluster organization organize this process? 2) What do you believe that the Seafood Cluster of Western Norway needs to accomplish in order to reach higher cluster maturity? 3) What will higher innovation growth mean for the Norwegian seafood industry? 4) What do you believe is the main facilitator for innovation growth within the Seafood Innovation Cluster? 5) What does sustainability in the seafood industry mean to you? 6) Have higher focus on sustainability been a trigger for innovation in the seafood industry? 7) Have higher focus on sustainability contributed to lower focus on main activities?
Ending
1) Summary 2) Is there anything you would like to add? 3) Is there anyone within your company or cluster-members, that would make a contribution to this research?

Short interviews to be conducted on the North Atlantic Seafood Forum (10 min.)
Introduction
1) *Introduction of interviewer(s)* 2) *Object of the Research* – Provide information sheet 3) *Information about confidentiality* - Provide consent form 4) *Permission to record the interview* 5) *Please tell us a bit about yourself*: a) Occupation b) Years within the organization 6) Description of the organization you are presenting (main business areas)
Questions
1) What do you believe will "lift" the Norwegian seafood industry in the next decade? (Salmon prices, innovation ++) 2) Does your organization take part in some innovative projects? Please tell. 3) How does your organization view the "Grønne Skiftet"?
Ending
1) Is there anything you would like to add? 2) Is there anyone within your company or cluster-members, that we could interview, that would make a contribution to this research?

Interviews with cluster members (45 min.)
Introduction
1) *Introduction of interviewer(s)* 2) *Object of the Research* – Provide information sheet 3) *Information about confidentiality* - Provide consent form 4) *Permission to record the interview* 5) *Please tell us a bit about yourself*: a. Occupation b. Years within the organization c. Description of the organization you are presenting
Questions
1) How would you describe your company's position within the Norwegian seafood industry? 2) How would you describe your organization's value chain? a. Global linkages? Or only national linkages? 3) Is your organization undertaking any innovative projects? a. Why did you undergo this project? b. Was this an internal project, or were external parties involved? c. If not, when did you last have one? 4) What your company's main reason for undertaking innovative projects? a. Innovative pressure? Productivity? 5) What does sustainability in the seafood industry mean to you? a. What are your thoughts on the increased focus on sustainability in the seafood industry? b. How does you organization approach the sustainability concept? c. Would you say that this is a driving force for innovation? d. Would you say that governmental provisions/incentives motivates innovation? Does this motivate your organization?
Ending
1) Summary 2) Is there anything you would like to add? 3) Is there anyone within your company or cluster-members, that we could interview, that would make a contribution to this research?

Exhibit 7 – Formulating questions for an interview guide

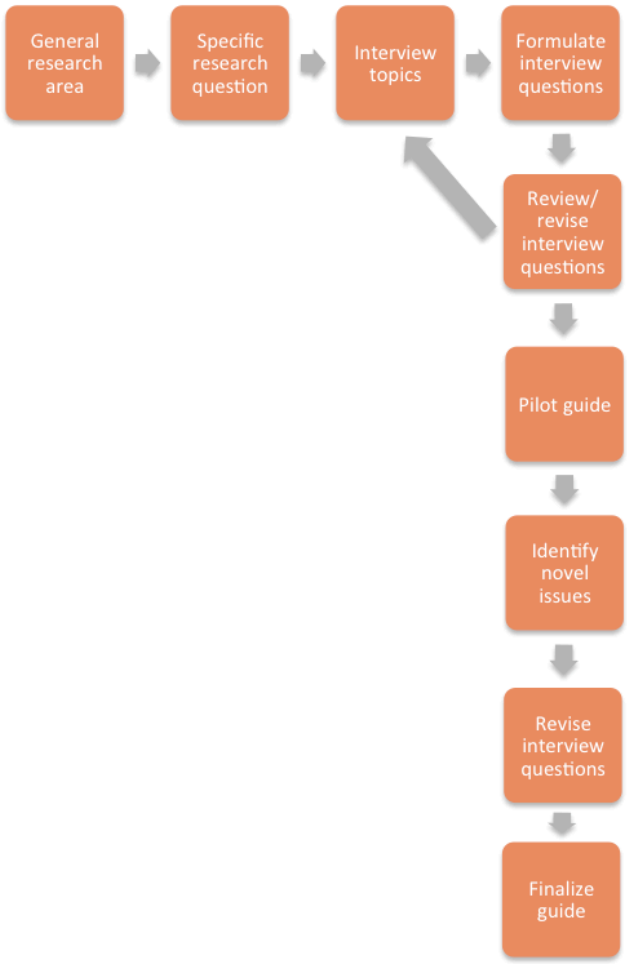


Exhibit 8 – Tentative Project Plan

JAN.	• Write and hand in preliminary thesis report • Extend literature and methodological foundation • Interview guides
FEB.	• Finish interview guides • Structure literary framework • Interviews with Innovation Norway and NCE Seafood Innovation Cluster
MAR.	• Week 10: Bergen: North Atlantic Seafood Forum and interview processes • Collect secondary data • Analyze interviews
APR.	• Deliver 1st draft to supervisor (approx. 30 pages) • Analysis of interviews and secondary data • Conduct more interviews if needed
MAY	• Deliver 2nd draft to supervisor (approx. 60 pages) • Analysis of interviews and secondary data • Review literature in accordance with the analysis
JUN.	• Go through notes from supervisor • Analysis of interviews and secondary data completed
JUL.	• Analyzing findings against theoretical foundations
AUG.	• Continue process from July • Aimed dissertation hand-in by 15th of August 2017

Exhibit 9 – Tentative Thesis Disposition

1.0 Introduction

2.0 Research Question & Aim

3.0 Research Methodology

- 3.1 Research Design
- 3.2 Sampling
- 3.3 Data Collection
- 3.4 Qualitative Data Analysis

4.0 Theoretical Foundation

- 4.1 Cluster Theory
- 4.2 Innovation
- 4.3 Sustainability
- 4.4 Theoretical Framework

5.0 Research Foundation: The Norwegian Seafood Industry

- 5.1 The Norwegian Seafood Industry
- 5.2 The Seafood Cluster of Western Norway
- 5.3 Western Norway Diamond Model

6.0 Cluster Programs in Norway

- 6.0 Norwegian Innovation Clusters
- 6.1 Cluster Requirements

7.0 Presentation of Companies

- 7.1 NCE Seafood Innovation Cluster
- 7.2 Innovation Norway

8.0 Analysis

- 8.1 Industrial Historical Development
- 8.2 Innovation in the Seafood Cluster of Western Norway
- 8.3 Sustainable Implications for Innovation
- 8.4 Emerald Model

9.0 Discussion and Conclusion

- 9.1 Discussion of Propositions
- 9.2 Strategic Initiatives/ Recommendations

10.0 Limitations

11.0 Appendices

12.0 Bibliography