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Innovation drivers at the firm level

An empirical study of the Norwegian seafood industry

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TITLE:

INNOVATION DRIVERS AT THE FIRM LEVEL
AN EMPIRICAL STUDY OF THE NORWEGIAN SEAFOOD INDUSTRY

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FOREWORD

This master thesis is the final work on my master degree in Economics and Business Administration, specialization in Business Administration. Studying in the University of Stavanger is one of the most meaningful and important milestones of my life.

First of all, I would like to express the sincerest thanks to my thesis supervisor, Professor Bjørn Terje Asheim. I am truly grateful him for devoting his time and effort for supporting me and giving me his most precious advice. Despite of his hectic work schedule, professor Asheim has always been so kind, supportive and responsive to all of my concerns and my need for help. His comments are highly insightful for my research study.

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PREFACE

Innovation has consistently been identified as a key factor for the success of economic growth and firm performances. It is highly relevant to study and understand what drives innovation and how potential factors characterize the different innovation types, especially, in nowadays context, when market and technological changes have become more unpredictable and uncertain. Understanding the drivers would allow business leaders and policymakers to stimulate a higher degree of innovativeness in the firms, the industry, and the country.

The driving factors of innovation can be distinguished by two different types: macro factors and micro factors. While macro-factors are the macro-environmental phenomena such as changes in demography, incomes, preferences, climates; micro-factors are the influences from micro-environments and have direct effects on business strategies, as well as on innovation strategies. In this research, those micro-factors refer to "Business objective drivers." Business objective drivers can be grouped into three main types: demand-driven, supply-driven, and policy-driven factors.

The thesis objective is to investigate if there exist significant relationships between those "business objective drivers" and the four types of innovation: radical product innovation, radical process innovation, incremental product innovation, incremental process innovation. The thesis is an empirical study using data from the online survey of 206 Norwegian seafood companies. The survey was conducted in 2016 by iProcess, the University of Stavanger. Both qualitative and quantitative analyses have been performed in this thesis. When it comes to the Norwegian seafood industry, this industry has been one of the most substantial contributors to Norway's economic development and innovativeness. A variety of technological applications and innovations have been seen in all aspects of this industry, from fishing, farming to processing and supplying, from equipment to biotech. Therefore, the Norwegian seafood industry is an interesting case study for empirical analysis.

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CHAPTER I: INTRODUCTION

Chapter I presents the research area and explain why the research topic may be relevant and useful to study, as well as to state the research questions as the fundamental base for further hypothesis elaboration. The thesis structure will also be defined in this Chapter.

The importance of innovation to the development of our modern world is undeniable. Innovation is a decisive contributor to economic growth, national wealth, social sustainability and resource protection. The level of innovativeness creates differences in the level of development between nations. Asian countries such as Japan, South Korea or Taiwan are great examples to illustrate how innovation allows late-developing economies to catch up with the global newest technologies and then grow quickly and greatly in only a few decades.

The failure in innovation ability also proves to correlate with economic stagnations. A symbolic high-tech empire like Nokia still collapses due to ineffective innovation strategies. That is to say, innovation to the economy no longer appears as a choice but a must. If a firm, an industry, an economy or a country desires to maintain and increase its competitiveness in the nowadays fast-changing world, it indeed must innovate continuously. The change in innovation and the development pace of technologies have become accelerated. In some cases, the leading technologies can be completely replaced by newer arrivals in only a few years. Firms, industries, and countries need good absorptive ability to acquire new knowledge and build up innovative competencies so as not to lag behind in the globalized competition.

Innovation, in general, has received remarkably wide attention of all participant groups in the society from scholars, business leaders to policy-makers. Research topics regarding innovation are diversified, such as economics innovation, innovation clusters, industrial innovation, innovation process, and innovation policy. Some of the narrow approaches are focused on innovation drivers and barriers. It is of high interest to study which driving forces are pushing behind innovation. Needless to say, uncertainty has become more significant since changes at the macro and micro environment are extraordinarily rapid and unpredictable. To understand the drivers of innovation is critical to maintaining a successful innovation performance and economic growth.

Despite the importance of understanding innovation drivers, the volume of research studies about this topic remains somewhat limited. Most of the research works are focused on macro environmental drivers rather than the drivers behind business strategies, for example, how the specific driving factors, such as entering new markets, or reducing costs, increasing production capacity, are correlated to the introduction of innovation. Those business objective drivers are highly relevant since it links directly to innovation strategies of firms.

Innovation can be characterized by outcomes such as product, process, marketing or organizational innovations, or by the degree of novelty such as radical or incremental innovation. Picking the two most crucial, popular innovation types and matching them with the degree of innovation novelty; the four main types of innovation: radical product innovation, radical process innovation, incremental product innovation and incremental process innovation have been the focal points in this piece of research of investigating their relationships with the business objective drivers. Good knowledge about innovation drivers might hugely benefit business managers and policy makers to stimulate innovation activities and raise the level of innovativeness in firms and countries.

When it comes to the research context, this thesis is carrying out empirical research with observations on a specific case, the Norwegian seafood industry. This industry of Norway is undoubtedly attractive for researchers to study because of its strong position in the global market as well as its innovation dynamics. Fortunately, with a long coast and a plentiful resource, Norway has been reputed for quality seafood products and a sustainable economic growth. Norway is the world largest salmon exporter. Regardless of intensive competition pressure of lower cost producers from Asia or Chile, Norway still exceedingly affirms its competitive edges thanks to advanced competencies in technology and innovation.

Norway has demonstrated its high level of innovativeness in all forms and aspects of innovation, from product to process innovation, radical to incremental innovation, and of all the industrial sectors from fishing and farming to supplying and processing. Concerning production technologies, Norway has been a pioneer in applying automation, robotics and smart digital technologies in farming, processing, and logistics. The Norwegian fish processing plants have been substantially modernized and digitalized in the recent years. The application of digital technologies increases productivity, product quality, and hygiene since it reduces considerably human errors and faults.

Moreover, a high number of innovative initiatives in production and supply chains, such as the project Fish 2.0 which allows all participants including all producers, suppliers, and consumers to track the fish from growing to being processed and distributed on the table, have been introduced. Norway has also achieved considerable successes in fish production by replacing vaccines with almost entirely use of antibiotics, which is not recommended for human health. Norway has always been a quick learner to adapt and also a quick developer of the latest technological applications in life and production.

The innovation performance of Norway is not only remarkable on the supply-side, but also on the demand-side. Innovations in the Norwegian seafood industry are also strongly driven by the market demand. More varieties of products have been developed to address an expansion of market segments, such as the emerging demands from developing markets. In a quick conclusion, the Norwegian seafood industry is an interesting case study with respect to innovation in a medium-tech industry.

Therefore, this thesis is interested in investigating the relationships of business objective drivers and innovation (which is also divided into radical product innovation, radical process innovation, incremental product innovation, incremental process innovation) of the empirical case, Norwegian seafood industry. The research questions of the thesis include three main points:

(1) What are the innovation characteristics of the Norwegian seafood industry?
(2) What are the driving factors behind innovation activities of the Norwegian seafood industry?
(3) Does it exist significant relationships between those driving factors and the four innovation types?

The first question concerns characteristics of the four innovation types distinguishing sizes, location, and sectors of the Norwegian seafood firms. The second question shows how the macro and micro environmental factors drive innovation activities of firms in the Norwegian seafood industry; those micro environmental factors will also be considered as business objective drivers which presumably have close and direct effects on the innovation strategies. The last question relates a hypothesis test to confirm if there exist some potential relationships between those aforementioned business objective drivers and the four innovation types.

As with empirical research, the thesis would begin with empirical observations on particular phenomena, next generalize the theoretical framework, then analyzing the data and finally interpret the results. This process also follows closely the empirical research cycle recommended by A.D de Groot (1969) who suggested that the empirical research would be conducted in five main stages: Observation, Induction, Deduction, Testing, and Evaluation.

- Step 1, Observation: The observations over a phenomenon would be helpful to provide insight and concern about the research questions
- Step 2, Induction: From the research concerns, the hypotheses would be formulated in alignment with assumptions resonated from the observation
- Step 3, Deduction: The analysis models are designed for the purpose of testing the hypotheses.
- Step 4, Testing: A process of analysis is conducted to test the hypotheses.
- Step 5, Evaluation: The interpretation of the analysis result will be discussed in combination with an explanation of the phenomenon.

The thesis is divided into seven Chapters:

- Chapter I, Introduction: Introduces the research topics, research questions, and thesis structure
- Chapter II, Background of the Norwegian seafood industry: Provides an understanding of the Norwegian seafood industry.
- Chapter III, Theoretical Framework: Presents relevant literature and theories of innovation and innovationin the seafood industry.
- Chapter IV, Research Hypotheses: Establishes the research hypotheses.
- Chapter V, Data, and Methods: Presents the data and methods used for the analyses.
- Chapter VI, Analysis: Explains the analysis results.
- Chapter VII, Discussion, and Conclusion: Discusses the findings and conclude the research.

CHAPTER II: BACKGROUND OF THE NORWEGIAN SEAFOOD INDUSTRY

In Chapter II, information about the global and Norwegian seafood industry will be presented, concerning the macro landscape, markets, competitors, competitive advantages and the value chain.

2.1 THE GLOBAL LANDSCAPE

FAO projects that there will be an increase in food demand by 50% by 2030 and 80-100% by 2050 due to the growth in population, income, and urbanization. Fish remains a crucial protein, being responsible for 17% of animal protein intake of the world in 2013 (FAO, 2016). The global fish consumption has also doubled to 19.7kg per capita within the past five decades (FAO, 2016) and increased by 1.1% compared to 2015 and 2016.

The increase in global seafood demand has resulted in a sharp growth of 3.9% in consumption from aquaculture after the decrease of 1.8% in consumption from capture fisheries. 1.8% is also the increase in the production supply of aquaculture production surging by 5%, while fisheries decline slightly 0.9% in 2016 compared to 2015.

Figure 1:

The world fish market at a glance

World fish market at a glance

	2014	2015	2016	Change: 2016 over 2015
		estim.	fcast.	
		million tonnes		%
WORLD BALANCE				
Production	**167.2**	**171.0**	**174.1**	**1.8**
Capture fisheries	93.4	93.5	92.7	-0.9
Aquaculture	73.8	77.5	81.4	5.0
Trade value (exports US$ billion)	**148.3**	**134.1**	**140.0**	**4.4**
Trade volume (live weight)	**60.0**	**59.9**	**60.0**	**0.2**
Total utilization	**167.2**	**171.0**	**174.1**	**1.8**
Food	146.3	149.4	152.8	2.3
Feed	15.8	16.5	16.2	-1.8
Other uses	5.1	5.1	5.1	0.0
SUPPLY AND DEMAND INDICATORS				
Per caput food consumption				
Food fish (kg/year)	20.1	20.3	20.5	1.1
From capture fisheries (kg/year)	10.0	9.8	9.6	-1.8
From aquaculture (kg/year)	10.1	10.5	10.9	3.9
	2014	2015	2016 Jan-Jun	Change Jan-Jun 2016 over Jan-Jun 2015 %
FAO FISH PRICE INDEX				
(2002-2004=100)	157	142	143	-1.0

Source of the FAO Fish Price Index: Norwegian Seafood Council (NSC)

Totals may not match due to rounding.

(Source: FAO)

Despite increase in the global demand, seafood demand in the Norwegian market has shrunk by 7% in 2016. The steady decline in Norwegian seafood consumption was the result of changes in eating habit. Young Norwegians eat much less seafood due to the price concern as well as declined preferences.

Table 1:

Changes in seafood consumption

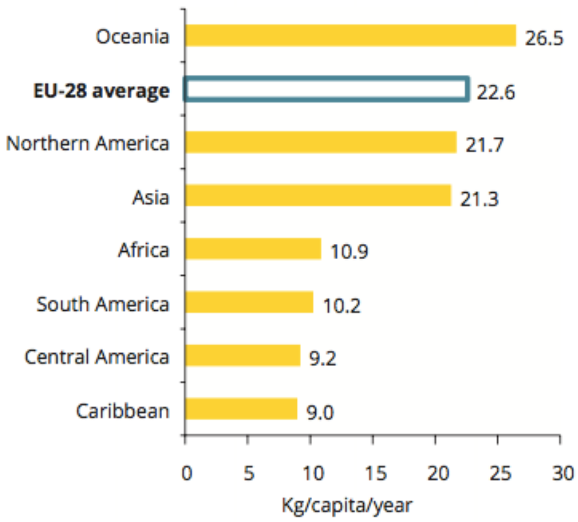
Category	2015 (tones)	2016 (tones)	change
Seafood in total	90296	84006	- 7%
Seafood natural fresh	18469	15003	- 19%
Seafood naturally frozen	13267	13576	+ 2%
Fish fresh fillet	13294	10180	- 23%

(Source: GFK)

Europe, also the primary market of Norwegian seafood industry, has the world second largest fish consumption per capita.

Figure 2:

The consumption of fish in the EU compared with the rest of the world (food supply quantity as kg/capita/year) in 2011

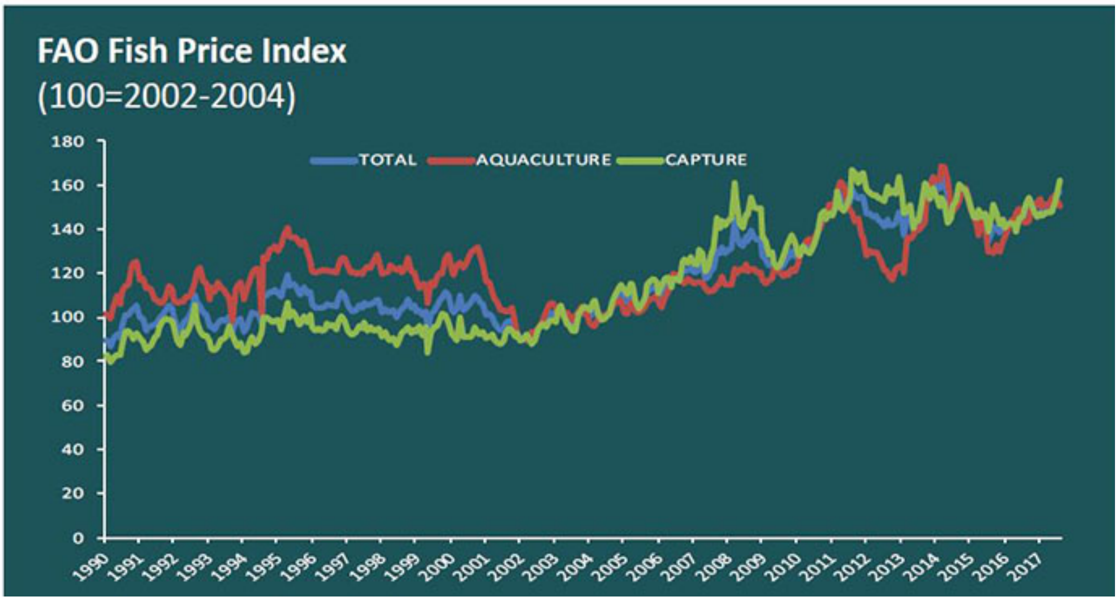


(Source: Seafood in Europe. FAO, 2016, FAO Food Balance Sheets: Food Supply Quantity).

According to FAO Fish Price Index, fish price (include six crucial species groups: salmon, whitefish, other fish, crustaceans, small pelagics, and tuna) fluctuated dramatically during 2010 and 2017. After 2010, price slightly went down in the period of 2012-2013 then stabilized again until 2017. Fish price gradually rose back by the end of 2017.

Figure 3:

FAO Fish Price Index from 1990 to 2017



(Source: Norwegian Seafood Council)

2.2 NORWEGIAN SEAFOOD PRODUCTS

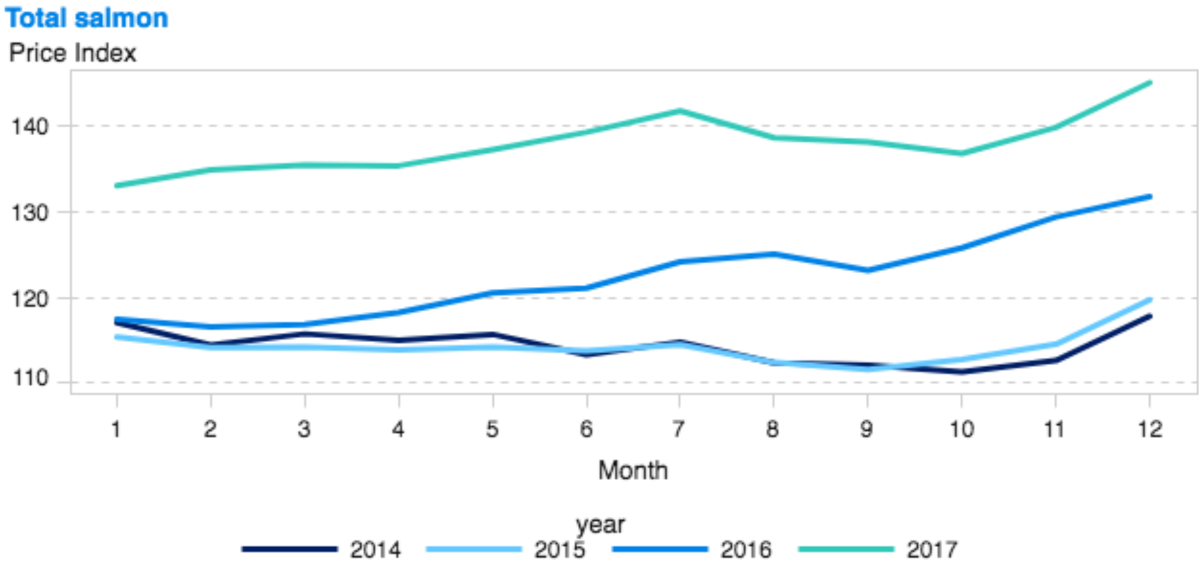
In the northern part of Europe with more than 83000 km coastline, the vast marine area of Norway is among the most productive and resourceful in the world for fishing and for aquaculture. The country's products are mainly cold-sea species such as salmon, cod, herring, haddock, mackerel, prawn, with salmon accounting for the most considerable export value of 61.5 billion NOK in 2016.

"Salmon is the common name for several species of fish of the family Salmonidae (e.g., Atlantic salmon, Pacific salmon), while other species in the family are called trout (e.g., brown trout, seawater trout)" (MarineHarvest website, 2018). In 2017, salmon export values 67.5 million NOK (increase 4%) of the total 94.6 million NOK in 2017. Salmon is a premium product, accounting for the smaller export quantity (36.5%) but the higher value (66.6%) in total Norwegian seafood export.

According to the Norwegian Seafood Council, during 2009 to 2018, the price of salmon and trout increased significantly compared to stable prices of the others. Comparing between 2017 and 2014, the price of salmon rose dramatically, although the quantity of salmon slightly decreased in the same period. It could be an explanation for the increase in total salmon export value.

Figure 4:

Salmon price during 2014-2017



(Source: Norwegian Seafood Council)

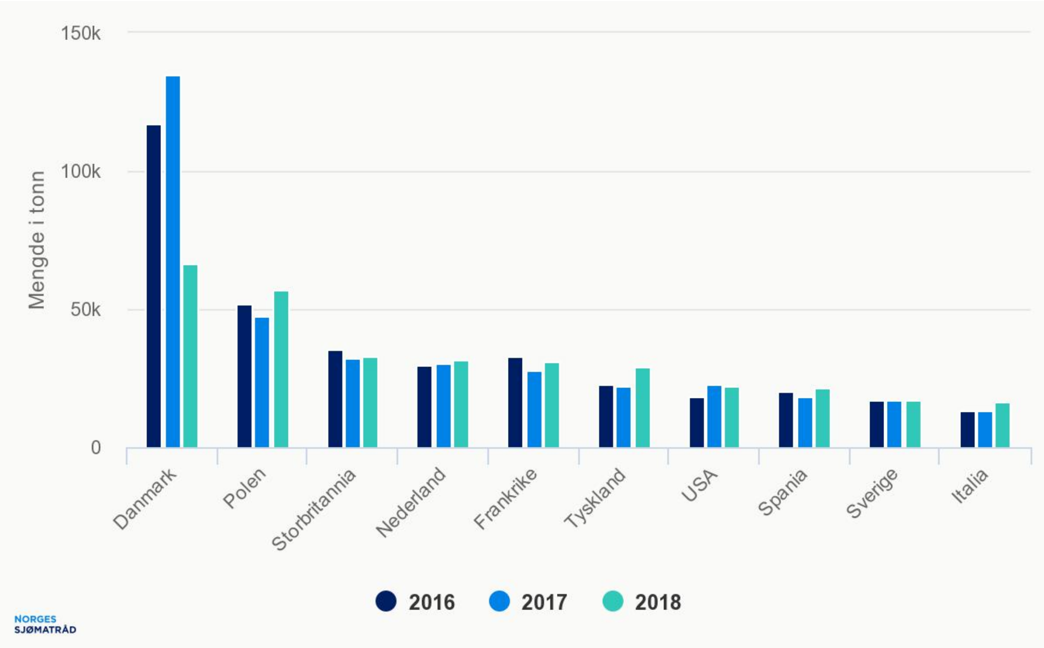
2.3 MARKETS

Since the ban on Russia market which used to be one of the most important markets for Norwegian seafood industry, EU market has increased its significance to Norwegian seafood industry. EU is the most prominent market of Norwegian seafood with 1.6 million tons of seafood, worth 61 billion in 2017. Denmark and Poland are the two domineering markets measured by export volume. In 2017, the increase in salmon price reduced the demand for salmon in Europe. Consequently, the decrease in demand led to lower salmon price in the last six months of 2017 (Norwegian Seafood Council, 2018)

The United States was the most extensive growth market in 2017. Together with the United States, Asia market, particularly China, has also been considerably expanded with the increase of 8% percent in volume and 12% in volume, promising to become an enormous potential market in a near future.

Figure 5:

The ten biggest export markets in 2016, 2017 and 2018 by average volume



(Source: Norwegian Seafood Council)

2.4 NORWEGIAN SEAFOOD INDUSTRY's COMPETITIVENESS

Concerning salmon, the most important exported fish of the Norwegian Seafood industry, Norway's main competitors in the salmon industry are Chile and Scotland. Chile has substantial advantages in cheaper production costs and low wages as well as its favorable access to big markets including South America and the United States. Chile dominated Norway in the period from 1997 – 2006 (According to Norwegian Ministry of Fisheries and Coastal Affair). However, in recent years, the situation has favored Norway. Salmon price of Norway's products remains stably high while that of Chile is declining along with the lowered demand. The primary markets of Chile are Japan and the United States while those of Norway are Europe and Asia.

In recent years, Chile was struggling with the emerging concerns of US retailers about antibiotic in salmon farming, the ban from its vast market in Russia and its high debts from the financial crisis in 2012. By contrast, Norway seafood exporters enjoyed higher export prices and revenues as the currency depreciated after the oil recession. Moreover, since 1987 Norway has increased the use of vaccine in replace for antibiotics. Despite the lower price, Chile's producers still increased their output quantity thanks to advantages in efficiency level and lower feed costs.

The competitive advantages of Norway in comparison with one representative competitor are summarized in the table below.

Table 2:

The comparison of competitive advantages between Norway and Chile

Norway	**Chile**
Advantages: - Good natural condition for salmon farming - Close collaboration between the industry and its partners (the government, suppliers, research institutes, etc.,) - Strong supports from the government. - Stable political institutions. - Proximity to Europe market - The higher degree of technologies and automation - The higher quality of products - High investment for research and innovation - Strong brand reputation	Advantages: - Proximity to US market - Favourable access and export regulations to American markets - Low wage costs - Low feed costs
Disadvantages: - High wage costs - High feed costs	Disadvantages: - Higher concerns towards fish antibiotic farming

(Source: Own illustration)

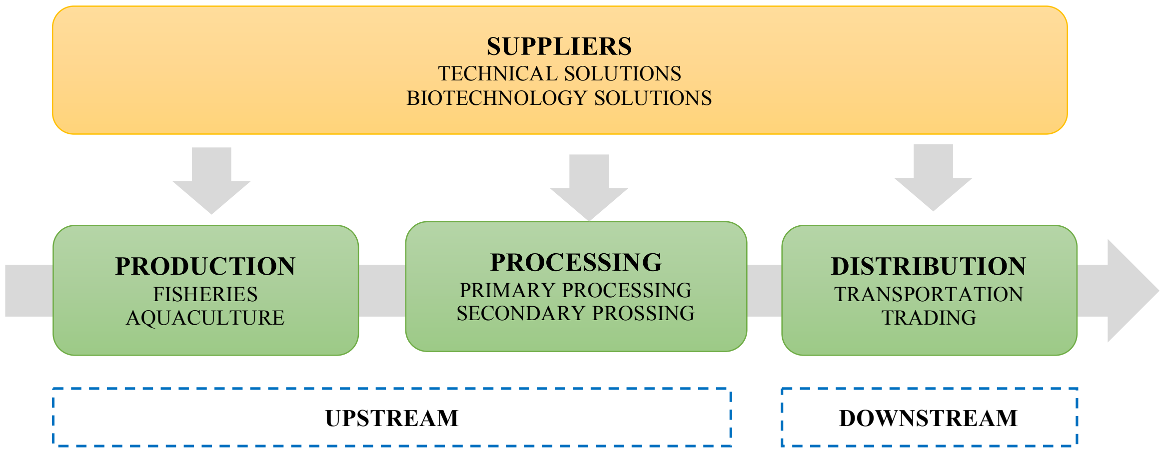
In the context of increasing preference towards processed and fillet products, processing market has become more competitive. Price also greatly concerns customers. Customers tend to compare products in the same range once they shop in retailers. Normal profit is equal to price minus cost. Since Norway is a high-cost country, the labor and material costs of Norway are remarkably high, so if price is not high enough, some Norwegian companies find it even harder to attain lucrative profits. Moreover, another major concern is fish diseases, sea lice and fish escape which destroy a large part of production. Therefore, Norway has spent a great amount of money on innovation development activities in order to address those problems. The innovation activities of the Norwegian seafood industry would be further discussed in the coming chapters.

2.6 THE VALUE CHAIN OF NORWEGIAN SEAFOOD INDUSTRY

The value chain of seafood industry is illustrated in the figure below. In that, fishes are produced either by wild fishing or farming. In the next stage, fishes will be processed by processing firms then packaged, before being transported and traded to domestic and international retailers and fish markets through distribution suppliers. It should be distinguished between primary and secondary processing. Primary processing involves slaughtering and gutting, while secondary processing regards filleting, trimming, portioning, smoking, or fermenting. Along the value chain, there is also an essential involvement of the providers of equipment, technologies and bio-technologies.

Figure 6:

The value chain of Norwegian seafood industry



(Source: Own illustration

Reference: The Norwegian Aquaculture Analysis 2017, Ernst & Young AS)

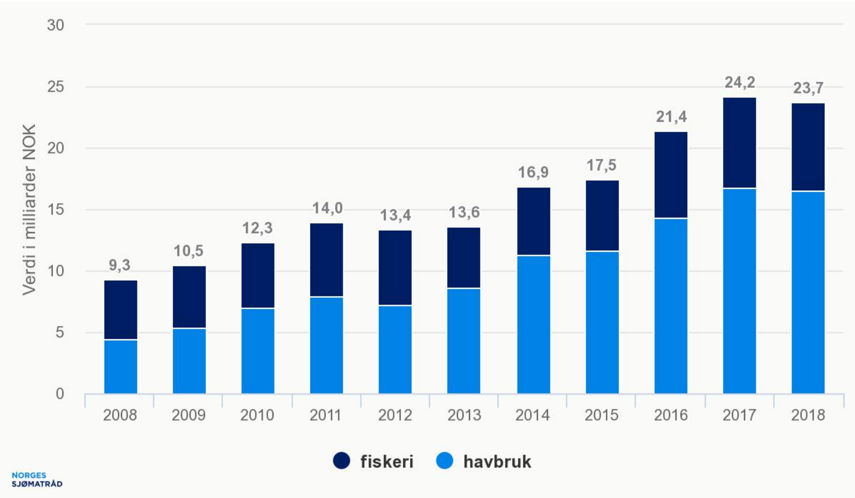
2.6.1 Production segment

The global population expansion has led to higher food demands. Fish is still an indispensable protein source. FAO reports that demand for seafood is projected to continue growing in the upcoming years. As a consequence, global seafood supply has experienced a drastic development to meet the market demand. In the context of more unstable economic, politic and climate events, aquaculture, as a way to secure the global seafood supply, has become increasingly important since the last decade.

In Norway, the aquaculture has witnessed tremendous growth, with the revenue increase of more than 200% in the last ten years (EY, 2016). Just in 2008, the volume of fish catching and fish farming was almost equal, then only ten years later the export quantity of aquaculture was three times more than that of the fishery. In 2018, 72% of export value derives from aquaculture while fishing is responsible for only 28%.

Figure 7:

Export of Norwegian seafood total a year by fisheries and aquaculture.



(Source: Norwegian Seafood Council)

In the Norwegian seafood industry, feeding and sea farming segment accounts for the most substantial contribution of EBITDA (Earnings before Interest, Taxes, Depreciation, and Amortization). This segment includes about 95% of small and medium companies and only 5% of large companies. More than 60% of revenue in this segment belongs to a few large companies. The top five companies by revenue in sea farming segment can be named, Marine Harvest Norway AS, SalMar Farming AS, Lerøy Midt AS, Cermaq Norway AS, Nordlaks Oppdrett AS (EY, 2017).

In spite of positive growth in revenue, aquaculture companies have been struggling with considerable issues such as sea lice and fish diseases, higher feed costs and environmental concerns. Those challenges have emphasized the need for innovations in biotechnologies and operation as the leading-edge strategy for cost competitiveness as well as ecological sustainability solutions.

2.6.2 Processing segment

Following the concept of EY (2017), the processing segment could be divided into two sub-segments: processing and packaging companies. The majority of both processing and packaging sub-segments is small and medium companies. The top five processing companies by revenue consist of Sekkingstad AS, Nils Williksen AS, Hofseth AS, Norsk Sjømat AS, North Sea Seafood AS. Despite increased salmon price and revenue growth, the profit margin in 2016, compared with 2015, was reduced by 10.2% for processing companies.

The processing sub-segment is modernized with new ways of processing and new technologies. Fishes are slaughtered and processed in some parts on the vessels. This new trend influences on cost and time saving as well as environmental footprint reduction. Moreover, digital technologies and automation have also been transforming this sector hugely. The high labour cost plus cheaper technologies are one of the reasons for Norwegian processing and packaging to increase the use of automation, robotic and digital applications. By applying new technologies and innovation, operation and personnel costs have recorded with a marginal decrease of 0.4% from 2015 to 2016 (EY, 2017).

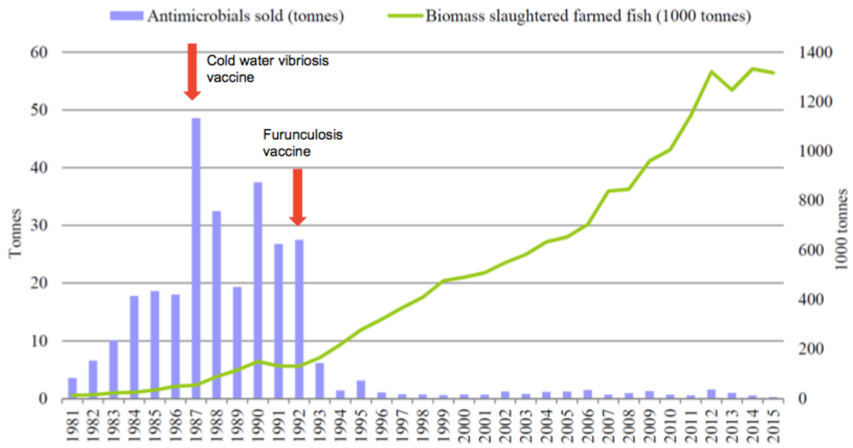
2.6.3 Supplying segment

In this segment, there are two main sub-segment of suppliers: technical solutions and biotechnological solutions (EY, 2017). Technical suppliers provide equipment for fishing, farming, processing and transporting, so-called vessels, well boats, barges, feeding systems, cages, sea-lice treatments, sensors and digital systems. The biotechnology sub-segment includes companies offering feeding ingredients, medicines, vaccines, cleaner fishes, and chemicals.

Diseases have an adverse impact on fish quality and production quantity. Sea lice has remained the most severe challenge for aquaculture, besides other disease problems such as pancreas diseases (PD), heart and skeletal muscle inflammation (HSMI) and infectious salmon anaemia (ISA) (EY, 2017). The use of antibiotic in Norwegian fish farming has dramatically declined to almost 0% since the 1980s. Norway has been investing into research and development of new vaccines and medicines to reduce risks of fish diseases as well as drug resistance of fishes.

Figure 8:

Total sales in tonnes of antimicrobials and biomass slaughtered farmed fish in 1000 tonnes.



(Source: NORM-VET UNN)

Apart from disease, feeding ingredients are another major concern. High feed cost poses a challenge to Norwegian seafood industry to come up with new feeding materials in place for wild feeding fishes. Vegetables and krill have been used more often in feeding salmons as it is more cost-effective as well as an environmentally sustainable solution.

In addition to biotechnology, technical suppliers also contribute with innovations to address the problems of fish diseases and to increase efficiency and reduce operational costs. Technical solution suppliers also hold a central role in diffusing know-how, knowledge and to level up innovativeness of the industry.

To the Norwegian seafood industry, the role of external competence providers is highly important. The supplying sector has always implemented innovation processes and have a collaboration with research institutions such as CREATE.

The supplying segment consists of mostly small and medium companies. The top five technical solution companies by revenues are Steinsvik AS, Akva Group AS, Aas Mek Verksted AS, Optimar AS, Egersund Net AS. Top five biotechnology companies by revenues are Pharmaq AS, EuroPharma AS, MSD Animal Health Norge AS, Nofima AS, Veterinærmedisinsk Oppdragssenter AS. The top five feed companies by revenues are Ewos AS, Skretting AS, BioMar AS, Marine Harvest Fish Feed AS, Aker Biomarine Antarctic AS.

2.6.4 Distribution segment

This segment includes the companies offering services for transporting production materials among the value chain partners and final products from producers to customers. Moreover, this sector also comprises trading companies whose business is to export Norwegian seafood products to foreign markets. Transportation companies remain lucrative profitable due to high demand for supply. However, trading companies, which profit margin is often low at 1-2% in previous years, has shrunk the profit to 0% in 2016 (EY, 2017). 93% of small and medium companies and only 7% of large companies cover this sector. 77% of revenue is generated by those most significant companies in this segment.

The top five trading companies by revenue are Marine Harvest Markets Norway AS, Lerøy Seafood AS, SalMar AS, Ocean Quality AS, Waynor Trading AS. The top five transportation companies by revenue consist of Roistein AS, Norsk Fisketransport AS, Sølvtrans Rederi AS, Bømlo Brønnbåtservice AS, Oppdretternes Miljøservice AS.

CHAPTER III: THEORETICAL FRAMEWORK

Chapter II presented the background of the empirical context. In Chapter III, the literature regarding innovation, its economic roles, its distinctive types, and its characteristics distinguished by the firm level and the seafood industry would provide the theoretical framework for further development of the hypotheses.

3.1 INNOVATION DEFINITIONS

Innovation has received greater interest among international scholars in recent years. The importance of innovation to the macro and microeconomic development is undeniable. Innovation boosted enormous growth of Asian economies such as South Korea, that, in only fifty years, have transformed itself from a late developing to one of the most developed countries in the world.

Innovation has its great impact not only on the macro level but also clearly on the micro level. A good example of innovative companies is Samsung, which has now become one of the most innovative and high-tech firms. This company entered late in the competition but soon caught up with the most modern and smart technologies to outpace its counterparts such as Nokia. Nokia, on the other hand, is an opposite case, which represents an innovation failure due to ineffective strategies of research and development. Positioning as a domineering player in the market for many years, Nokia lost dramatically its competitiveness because it did not predict well market shifts to facilitate the right strategies of innovation.

Thus, it is highly important to understand about innovation, what it is, why firms innovate or not innovate, and how innovation strategies effect on the business context. With respect to the definition, 'Innovation' is distinguished from 'Invention' by Schumpeter, the famous economist and re-mentioned by Jan Fagerberg in The Oxford Handbook of Innovation (2005). 'Invention' is defined as *"the first occurrence of products, services or ideas (page 4)"*. In general, 'Innovation' is considered as a broader concept as *"the first attempt to carry it out into place (page 4)*."

OECD (2005) defines that an innovation is an implementation of a new or significantly improved product (goods or service), or process, a new marketing method, or a new organizational method in business practices, workplace organizations or external relations. An alternative definition emphasizes the roles of knowledge and information to innovation, that innovation is the combination of existing knowledge and resources to open new opportunities for business or future innovation (Jan Fagerberg, 2005). In several books and documents, innovation also refers to "Technological changes," and "Technological progress."

Innovation is also a powerful explanation for the gap of wealth and growth between countries, regions, and firms. Countries, regions or firms with the higher degree of innovation tend to have also higher productivity and better economic performances than the others with the lower degree of innovation (Jan Fagerberg, 2005). The Solow growth model indicates that: Q= A(t)*f(K,L). In that, A(t) represents "technological changes" in time t. Q is the quantity volume. K is capital and L is labor in use for production. Technological change is an exogenous factor which does not affect changes in capital and labor used in the model. The estimation shows that the factor of technological changes can shift the production function upwards. In other words, with innovation or technological progress, production quantity can be increased.

The positive correlation between innovation and competitiveness is also mentioned in the study of John Cantwell (2005). The competition of firms activates innovation and, in return, innovation increases the firms' competitiveness by improving product quality, enhancing efficiency and lowering costs. Consequently, competition and innovation together build up production capacity and increase the market demand of the industry.

When it comes to business, firm's final goal is profit optimization. As mentioned above in Solow's growth model that technological progress and innovation could increase productivity, lower the cost, transform the market and expand new opportunities, firms finance innovation activities which promisingly generate revenue. Innovation, however, is uncertain and perhaps does not secure a profitable turnover in the short term. Investments for some innovations, such as automation and digitalization, may be capital-intensive. So, small and medium companies with restraint resources of capitals, human resources or technological capacities might find it difficult to invest actively in innovation activities. To make decision of investing in specific innovation activities, firms regard market and production strategies which are the decisive factors for firms to earn profits.

William Lazonick in his study (2005) listed the three characteristics of innovation: uncertain, cumulative, and collective. First, innovation process is uncertain as "*what can be learned about transforming technologies and accessing markets can only become known through the process itself (page 30).*" Second, innovation process is cumulative while "*learning cannot be done at once, instead, what is learned today would be the foundation of future knowledge (page 30).*"

Last, innovation process is collective since "*generating knowledge requires collaboration between different partners in the system with distinct capacities and abilities (page 30*)."

The idea that "innovation process is collective" is also aligned to perspectives of other scholars that "innovation is not linear." In a conventional view, innovation is viewed as a linear model with distinct stages from science to development before production and marketing. Opposing to this point of view, Stephen Kline and Nathan Rosenberg (1986) argued that innovation can also be a collaborative model in which the knowledge can derive from the experiences of doing, using and interacting. The process of new ideas, trials, failures, and feedbacks would be repeated until the new products or process become mature. This process involves collaboration of all different partners in the innovation system, including firms, public institutions, universities, suppliers and consumers. In some settings, the experiences, and feedback from consumers and suppliers, as well as partners are the most important to innovation in firms (Von Hippel, 1998; Lundvall, 1988, Fagerberg, 2005).

3.2 MAIN TYPES OF INNOVATION

3.2.1 Product, Process, Marketing, Organizational Innovations

Innovation is often classified in four different types, including "Product innovation," "Process innovation," "Marketing innovation," and "Organizational innovation" (OECD, 2005). In that, product innovation and process innovation are the most mentioned since they hold prominent roles in business strategies.

- *Product innovation* refers to the introduction of new or significantly improved products, services to the market and consumers (OECD, 2005). Product innovation can be brand new products which have never been introduced in the market, but it also can be some newly added features, functions, components, new materials, and packaging.

- *Process innovation* represents the implementation of new or significantly improved production and delivery methods (OECD, 2005). It can be the changes in equipment, software, production techniques, supply chain, and logistics.

- *Marketing innovation* is defined as the application of new marketing methods, including changes in packaging, design, product placement, pricing, channels, and branding. (OECD, 2005).

- *Organizational innovation* pertains to the implementation of new organizational methods such as new organizational structure, business practice, management system employee welfare. (OECD, 2005).

In the limited scope of research, this paper mainly focuses on the first two types: Product and process innovations which have huge impacts on the demand and supply sides and firm performance.

3.2.2 Radical and incremental innovations

Kenneth B. Kahn (2018) in his study "Understanding Innovation" mentioned how innovation should be classified by the outcome, process, and mindset. In that, product, process, marketing, and organizational innovations are an illustration of how outcomes distinguish innovation. In the same study, Kahn also mentioned a common misleading understanding about innovation that many believe innovation must be something completely new and radical in nature. In fact, innovation can be simply adjustments or improvements in some features or function details. Besides outcomes, the degree of novelty also defines the types of innovation: radical and incremental innovations. OECD (2005) stated the phrases 'New to the company' and 'New to the market' which might be related to the views about 'Radical' and 'Incremental' innovations to some degree.

Radical innovation pertains to the entirely new arrivals of products, services, or production and delivery methods, which have never been introduced to the company and the market before. Some of the radical innovations are disruptive, which means, they might shift the whole conventional way of consumers and producers doing things. Assembly line is an example. The world changed the production method entirely from manual to mass production since the first assembly line was invented in the 1910s by Henry Ford. The world continues to evolve through radical innovations. In recent years, the emerging of automation, robotic and digitalization has also been transforming production of the seafood industry.

Incremental innovation, in another way, means the significant improvements, adjustments, updates, and upgrades in technical specifications based on the foundation of existing products, service, and production methods. This form of innovation can be new to the companies, means being newly adopted by the company, but not necessarily new to the market. Incremental innovation is as equally vital as radical innovation. In the perspective of firms, incremental innovations should be more applicable and safer to invest in while radical innovation is way more cost and time-consuming.

Radical and incremental innovations can be matched across product and process innovations to form the four main types of innovation, that:

	Radical	*Incremental*
Product	Radical product innovation	Incremental product innovation
Process	Radical process innovation	Incremental process innovation

In the belief that different driving factors make different effects on different innovation types, this study considers which drivers give significant meanings to these four innovations.

3.3 INNOVATION AT THE FIRM LEVEL

The foremost goal of a firm is to enhance its competitiveness and profits. There are various strategies for firms to achieve this goal, either by cost-cutting or by value-adding. 'High-road strategy' explains the strategy where companies aim at innovation-based and value-adding activities, while 'Low-road strategy' explains the strategy where companies aim at cost-cutting activities. In the complex business context nowadays, although cost maintains one of the most important factors in business, the strategy of cutting costs appears no longer enough to be applied alone. Consumers demand a better variety of choices and values once they shop and compare one product brand to another. Innovation-based strategies help firms to differentiate themselves from their counterparts in the market. However, the decision of following which strategy is also depended on the company's resources and ability.

Firms are essence of an industry and a country. When it comes to innovation's importance to firms, innovation works primarily at the firm level before diffusing its effect on the industry and then the economy. Innovation is particularly indispensable to firms to maintain and enhance competitiveness over their competitors. The market has experienced fluctuations and more unexpected downturn events. Besides, changes in demography, consumer preferences, technological progression and environment demand firms to stay at flexible mode with quick reactions to situations. Therefore, innovation holds a key role to firms, and firms must continuously innovate new products, production process, marketing schemes and business models to quickly adapt to changes.

Innovation influences greatly on both demand and supply side of firms. On the supply side, firms gain a competitive edge by fostering process innovation which enhance productivity and, as the result, cut labor and material costs. Accordingly, firms expand production capacity and earn higher profit margin. The power of firms in the market will be strengthened and, perhaps, its market share may also increase.

If process innovation effects the supply side, product innovation and marketing innovation has a stronger effect on the demand side. Product and marketing innovations react to consumer preferences due to demographic changes such as income, gender, immigration. Firms gain competitive advantages by product innovations which stimulates higher consumption from consumers and, thus, results in the increase in company revenue and market share. Marketing innovation, on the other side, is a strategy for firms to differentiate them and their products in the market. It might also enhance consumer's favors toward the company's products and services.

Product, marketing, and process innovations are equally crucial to a firm's competitive advantages. They are also interrelated and supportive of each other. On the one hand, if production volume increases on the supply side but there is no increase in the demand side, firms hardly sell more and earn higher profits. Similarly, a new product or changes in marketing schemes could require further changes in production methods. For example, the new product feature or new packaging might expect certain adjustments on production lines and techniques. It can be said that product, process, marketing, and organizational innovations are not independent bodies but interactive to have an overall effect on firm performance.

3.4 INNOVATION AT THE LOW AND MEDIUM TECH INDUSTRIES

Though responsible for a substantial contribution to the economy, low and medium-tech (LMT) industries often receive lower public attention than the high-tech ones. LMT industries and high-tech industries are much different in comparison of their innovating characteristics, and those differences have been examined in a number of academic papers.

Innovativeness of high-tech industries is higher than that of LMT industries. Many high-tech industries such as the automobile, information, computing have always maintained a forefront position of inventing and applying latest technologies in the production. Numerous disruptive, radical innovations, namely, assembly line, robotics, chips, and sensors, come from this industry before spreading their effects on other lower-tech industries and completely changing the world.

On the other hand, LMT industries have lower innovativeness. In these industries, incremental and DUI (Doing-Using-Interacting) innovations are more likely to happen than radical and formal STI (Scientific and Technologically-based Innovation) innovations (Von Tunzelmann & Acha, 2005; OECD, 2005). Because most of the highest and latest technologies are innovated by the high-tech industries, thus, firms in the LMT industries need to have good absorptive abilities in order to adopt knowledge and technologies.

Product characteristics of the high-tech and LMT industries are also distinctive. While products of high-tech industries are often distinguishable, products of LMT industries tend to be more homogeneous. Products of LMT industries are somewhat "necessities" with inelastic demands, which can be satiated in response to increased consumer income (Von Tunzelmann & Acha, 2005). So, it is of high importance for LMT firms to differentiate their products from rivals in the market and stimulate the market demands.

For that reason, innovations in LMT industries tend to be driven by market demands, and product innovations are crucial to this industry. Innovations, such as new products, new features, tastes, new segments, improved quality, are believed to become a catalyst for stimulating consumer preferences toward the products and expand market opportunities.

Besides demand driving factors, production-oriented factors alongside the global technological advance also play a role as driving forces of innovation in this industry. Especially for the food and seafood industries, requirements for higher biotechnologies, smart and environment-friendly materials, advanced production instruments and equipment are decisive factors to enhance production efficiency and cost advantages. Regularly, those innovations are provided by high-tech firms or public laboratories. That is why technological suppliers have substantial impacts and hold close relations with production firms in LMT industries (Von Tunzelmann & Acha, 2005).

3.5 INNOVATION AT SEAFOOD INDUSTRY

Von Tunzelman and Acha (2005) recommended that food industry can be classified as a low-tech industry. This might be true in the context of ten years ago while production in this industry has still relied more on labor work and simple production methods. Also, the market was still more predictable at that time than it is today.

However, the claim might no longer be hold in nowadays context, since production methods have become more sophiscated. Moreover, today market has become much more complex and competition is tougher. Even if the seafood industry does not have many invention breakthroughs as high-tech industries do, it has been experiencing significant transformations of innovation and profound market changes. To bring the fish from farm to table involves a variety of innovations for equipment, biotech, logistics in all stages from producing, processing and delivering. To the Norwegian seafood industry, research activities are highly important, particularly in relation to fish diseases, breeding, feed, technology, and new species (Olafsen, SINTEF, 2007). Table 3 illustrates the innovation activities by the value chain flow in the Norwegian seafood industry.

Table 3:
Innovations in the Norwegian seafood industry

	UPSTREAM		**DOWNSTREAM**
Segments	**Production**	**Processing**	**Distribution**
Product innovation	• Slowly matured salmon. • Environment-friendly fishes • Genetically modified fish.	• Processed products (e.g., filleted fish) • Branded products (e.g., Lofoten salmon) • Ready-to-use products (e.g., sushi, fish salad) • New tastes (e.g., Smoke, fermented) • New variety (e.g., Fish oil protein) • New packaging	
Process innovation	**Fishery:** • New equipment (vessels, gears) • Climate track • New fishing methods **Aquaculture:** • Automated & digitalized feeding,	**Production:** • Automated and digitalized production line **Biotech:** • High pressure • Super chilling (preservation)	• Digitalized supply chains

	monitoring, harvesting • New feeding raw materials • Fish vaccines • Fish 2.0	

(Source: Own illustration)

Thus, innovation activities in this industry are driven by both demand and supply factors, in addition to other exogenous incentives such as environmental and politic regulations. A variety of implementations in both radical and incremental, product and process innovations have been contributing to the rapid development of the Norwegian seafood industry.

When it comes to process innovations, a study of Asche, Roll, and Tveterås (2017) has provided insights in how the Norwegian salmon sector has taken advantage of technological innovations to boost productivity since the 1980s. In the period between the 1980s and 1990s, salmon aquaculture sectors have experienced an impressive productivity growth, which led to a sharp decline in production costs to one-third (Asche, Roll, Tveterås, 2017).

The major contribution belongs to radical innovations in new feeding materials and fish vaccines (Asche, Roll, Tveterås, 2017). A vast amount of investment for R&D and formal innovation process of the "'Science-Technology-Innovation' type has been funded by the government in collaboration between the industry and universities, and public research institutions. Norway has replaced the use of antibiotic by vaccines which benefits both the fish and consumer health. It credits Norway an excellent reputation in the global market position for high quality and safety of products.

Moreover, feeding technologies are a central strategy to aquaculture while the wild fish stock is resource-constrained and expensive. Fish feeding represents more than 50% of the expenditure of salmon production costs (Asche, Roll, Tveterås, 2017). New fishmeal materials such as concentrated algae are practical solutions for farmers to meet feed conversion ratios of 1:1 (Verlasso, 2018). Although the success in biotechnologies of fish vaccines and feeding is considerable, the industry is still in high concerns of fish diseases, sea lice and fish escape which caused an enormous loss to Chilean salmon farming industry some years ago. Thus, it has been a pusher for the industry to introduce more innovative solutions for those challenges.

Apart from biotechnology, the seafood industry has also been through remarkable changes in techniques and equipment of fishery, aquaculture, and processing. Automation has been implemented in fish feeding and monitoring since the early 1990s, increasing productivity per employees by several times (Asche, Roll, Tveterås, 2017).

Following that, the degree of automation, robotics, sensors in combination with the digital system has been continuously upgraded in the Norwegian seafood industry during the last ten years. Automation and digitalization reduced a large proportion of the high labor cost in Norway. Furthermore, the automating system helps detect advance system faults, fish health, environmental changes to reduce risks of loss due to uncertain climate changes, fish diseases or machinery damages.

With regards to Norwegian fish processing factories, fishes are now processed and filleted in perfectly measured cuts by automating robotics, as well as high-standard controlled by smart sensors and digital system. The Norwegian Government emphasized the policy of the automation of fish processing is one of the central strategies to increase product quality and reduce production costs (especially the labor costs), and, accordingly, to enhance competitiveness of Norwegian seafood products in the global market (Skjøndal Bar, 2015).

The development in applications of automation and digital technologies happens not only in salmon sectors but indeed in the whole seafood industry in Norway. Nofima (2010) provided an example of the Pelagic sector that consumers of this sector demand a large quantity of supply in a short amount of time. With faster freezing and automating handling, the production capacity has been increased, and cost per kilo was, by that, reduced significantly. The volume of filleted fishes rose, and more fishes were produced without being touched by human hands (Nofima, 2010).

Regarding storage and preservation after production, biotechnologies and packaging technologies are an immediate concern to ensure the quality and shelf-life of this highly perishable kind of food. Nowadays, consumers set higher expectations for quality, hygiene, and no or fewer chemicals and additives in products. The recently sophisticated techniques in preservation and packaging such as super chilling, high pressure, modified atmospheric packaging are replacing the use of thermal or chemicals in the food industry. Those innovations help to maintain the nutrients and original tastes in the foods, and at the same time, prolong the product life.

Innovations in the seafood industry have not only changed how to produce the fish, but also which kinds of fish products are. Various radical and incremental product innovations have contributed to the expansion of market demands and opportunities for this industry. Marine Harvest, the Norwegian seafood company and one of the largest companies in the world, comes up with a species of salmon which can mature more slowly to get to the slaughterhouse and then to retailer shelf in 'real time.'

By this food industry in general and seafood industry in specific, "real time" is a difference-maker to business success as products must be planned to get from the producers to end users in the right amount of time so that the products are still in an optimal condition of quality and taste. The other example of product innovations is the genetically modified fish which is somewhat debatable still. While farming land resources become more restraint, and the climate change becomes more uncontrollable in recent time, genetically modified salmons have been successfully developed in Canada and are expected to become an additional supply source.

Additionally, product innovations also occur in the forms of end products. Changes in consumer lifestyle, preferences and demography have fostered the development of more product varieties. There are more ready-to-cook products such as processed, filleted fishes or ready-to-eat products such as sushi, fish salad. Sometimes, incremental innovations in the form of products features added such as new tastes like smoked, fermented or fish oil products could also trigger more consumptions.

Concerning market-oriented innovations, a study of Asheim (2014) provides an insight into the vital role of value-creating innovations besides cost-cutting innovations. Asheim distinguished between the cost-cutting innovation as process innovation and value-creating innovation as product innovation and market innovation.

While product innovation is the primary form of innovation to create values, marketing innovation has also become more crucial to increase values. However, this type of innovation is often neglected compared to product and process innovations. It is emphasized that cost-cutting and value-creating should be optimized together to have a whole effect. In the case of the Norwegian seafood industry, process innovation has always been a strength as Norway has a strong capital resource. However, market-oriented innovations can still be done better with more activities to differentiate and enhance the competitive advantages of Norwegian products from other strong competitors in the global market. There has been a gradual increase in the market-oriented innovations in the Norwegian seafood industry. Lofoten Salmon is an excellent example to illustrate how a Norwegian seafood product brand is built up. A good story of how the finest quality salmon is produced in one of the most famous sites in Norway, Lofoten, in conjunction with beautiful, premium designs have set a premium position of the product in the market, and of course, earn the company lucrative revenues.

Last but not least, the innovation activities have been implemented throughout all stages of the seafood industry from how the fishes are caught or produced, then processed and, after, distributed to the consumers. As mentioned above, in food and seafood industry, timing is a key. The stock of this kind of perishable foods should be planned and delivered in the right manner of time, not too soon and not too late. That is how the role of supply chain and logistics matter significantly to this process. As one of the process innovations, supply chain innovations should also be acknowledged in an overall picture. One of the most brilliant ideas of Norwegian seafood industry is the application of traceability in the fish supply chain. Fishes can now be tracked from its origin until delivered to the consumers by a smart label, which is also able to alert the distributors if the required temperature for standard quality is beyond control. Fish traceability is also way more manageable for all partners in the supply chain to be on the same track of the system.

In the next part of this thesis, drivers of those innovations will be discussed to examine which are enablers of product and process innovations in the Norwegian seafood industry, and, thereby, to form conceptual hypotheses for testing the casual relationship between the strategic drivers and innovation types in the specific case of the Norwegian seafood industry.

CHAPTER IV: RESEARCH HYPOTHESES

Chapter III reviewed theories of innovation, innovation at the firm level and in low, medium-tech industries. Chapter IV continues to elaborate the theories of innovation drivers and formulate the research hypotheses in respect to business objective drivers and innovation.

4.1 THE DRIVERS OF INNOVATION

Innovation strategies refer to the strategies of how firms decide to introduce the forms of innovation: product, process, marketing innovations and radical, incremental innovation. With limited resources of capital, technology level, or human resources, firms choose innovation strategies driven by some specific factors, and those factors should promisingly cause profitability.

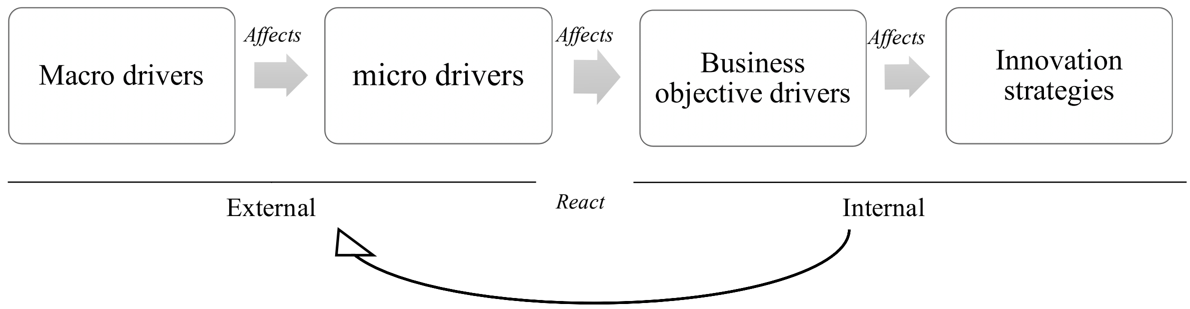
About the definition, drivers or driving factors of innovation refer to incentives or forces that can enable innovation to happen. In this research, innovation drivers are distinguished as 'External factors' which are those from the macro and micro environments, and as 'Internal factors' which derive from firm's business objectives. While business objective drivers are endogenous and controllable, macro and micro drivers are exogenous and hardly manageable. All external and internal driving factors are closely linked and have a solid influence on each other.

In Oslo Manual: The Guidelines for Collecting and Interpreting Innovation Data (2005), OECD has defined so-called 'Business objective drivers' as 'Objectives,' meaning "*Those may relate to products, markets, efficiency, quality or ability to learn and to implement changes. Identifying enterprises' motives for innovating and their importance is helpful when examining the forces that drive innovation activity, such as competition and opportunities for entering new markets… (Page 106).*" An example to showcase how those business objective drivers influence on innovation strategies is that, in low-road strategy, firms target to reduce the production cost per unit. Thus, firms in this business strategy are more likely to invest in process innovation to increase production capacity and lower production costs. By contrast, firms with high-road strategy having more attention on value-added or new products perhaps would be more interested in product innovations. Business objective drivers have a substantial impact on firm's innovation behaviors.

Figure 9 illustrates the flow of how the drivers cause innovation strategies. Firms are entities in the whole economic system so changes in the external environments have strong impacts on firm's behaviors. According to the flow chart, macro-level drivers have effects on micro-level drivers, then micro-level drivers impact on business objective drivers, and accordingly, business objective drivers have following effects on innovation strategies. Macro and micro drivers are external factors while business objective drivers and innovation strategies are internal factors. Innovation strategies are firm's reactions to macro drivers to adapt its firm business to the external environments. For this reason, a firm that does not have adaptation ability to the external environments and fails to innovate might accordingly lose its competitiveness in its market. Figure 10 provide a more specific example regarding this claim to demonstrate the connection between the driver types.

Figure 9:

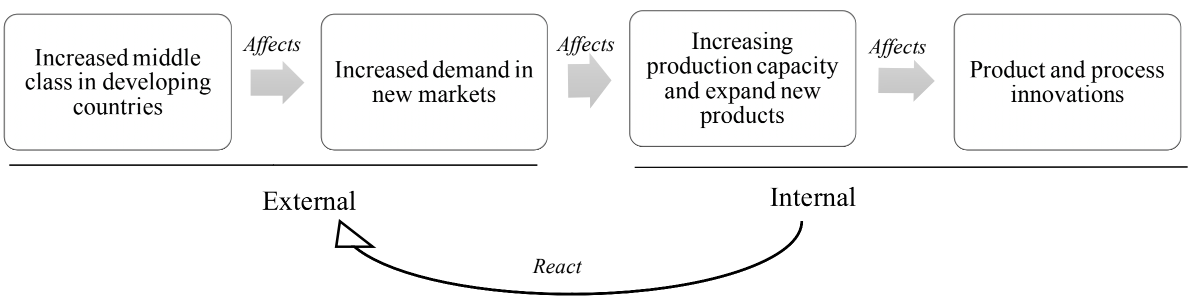
Flow of the innovation drivers



(Source: Own illustration)

Figure 10:

The example of innovation drivers



(Source: Own illustration)

Back to the context of the Norwegian seafood industry, empirical observations of this industry again affirm the acclaim about the drivers having their effects on innovation. Table 4 summarizes the drivers and following innovation strategies. The introduction of product innovations was caused by business objectives to increase the range of products, enter new markets, increase or maintain market shares. Those business strategies are linked back to the global fish demand such as growing incomes of the new market, urbanized lifestyle, enhanced awareness of health and the like.

This claim is also valid for supply-side drivers on process innovation. The macro factors such as higher demand for fish supply due to increase in population and income; the rise in wage and material costs; plus, the more advanced development of marine/ digital/ bio technologies drive firms to business strategies of increasing production capacity, reducing production cost per unit. Thereby, firms must come up with process innovation as solutions to address challenges or seize opportunities to maintain their competitive edge in their market.

Table 4:

The drivers of innovation in seafood industry

Macro drivers	**Micro drivers**	**Business objective drivers**	**Innovation strategies**
Growing disposable incomes in emerging markets & increase in the world population	Increase demand in new market	Increase capacity for production Enter new markets or increase market share	Process innovation (e.g., automation & robotics, biotech) Product innovations (e.g., processed fish, branded fish)
More high-class consumers	Demand more premium products	Increase range of products	Product innovations (e.g., premium brand fish Lofoten Salmon)
Decreased interest in fish of Norwegian young consumers	Declined demand of fish in Norway market	Increase range of products	Product innovations (e.g., processed fish, branded fish, sushi, fish salad)
Health awareness of consumers	Higher expectations for more quality products	Improve quality of products Replace outdated products or processes	Process innovations (e.g., biotechnologies in aquaculture, preservation and storage)

Urbanization – fast moving lifestyle	Demand on more product varieties (ready-to-eat, filleted processed fish)	Increase range of products Replace outdated products or process	Product innovations (e.g., processed fish, ready-to-use fish sushi, fish salad)
Governmental policy to increase wage	Increased production costs, decrease competitiveness	Reduce unit labor cost	Process innovations (e.g., automation, robotics) Product innovation (e.g., slowly matured salmon)
Growing cheaper fish exporters & Increase in input and feed materials	Increased production costs, decrease competitiveness	Reduce material and energy costs per unit produced	Process innovations (e.g., new feed materials, automation)
Development of biotechnologies, digital technology, marine technology.	Increased supply quantity	Increase capacity for production Increase flexibility for production	Process innovations (e.g., automation; biotechnologies in aquaculture, processing, fishing; fish traceability)
Growing concern about negative environmental impact		Reduce environmental impact	Process innovations (e.g., biotechnologies in aquaculture, processing; waste management)
Governmental policy to enhance Health and Safety (HSE) at work		Improve HSE for employees	Process innovations (e.g., increase more safety for employees)

(Source: Own illustration)

As with the strong influence of drivers on innovation, it is absolutely relevant to examine this concern. The relations between innovation drivers and innovation performance have been investigated in several studies[1][2][3][4][5]. However, most of them mainly pay attention on external drivers than on internal, business objective drivers.

[1] Josef Taalbi, 2017.
[2] Katharina Fellnhofer, 2017.
[3] Joao Ferreira et al., 2015.
[4] Eirin Bar, 2015.
[5] Nanja Strecker, 2009.

The same report of OECD in 2005 emphasizes the role of business objective drivers that "*Identifying the factors that drive innovation and those that hinder it is of great value for understanding the innovation process and for formulating innovation policy. Interest in measuring innovation is due to its relation to the performance of enterprises, industries, and the economy as a whole (Page 106).*" As can be seen, contrasting to the significant roles on in innovation performances, business objective drivers have received particularly little interest. Therefore, it calls the need for more studies in this field of research.

4.2 THE RELATIONSHIPS BETWEEN BUSINESS OBJECTIVE DRIVERS AND INNOVATION

Business objective drivers are business strategies which incentivize the implementation of innovation strategies for product, process, market. OECD (2005) has suggested a list of potential business objective drivers (which is called "objectives" in OECD document). Business objective drivers can be distinguished in three main groups: demand-driven, production-driven, and policy-driven.

OECD (2005) suggests that the objectives of product and marketing innovations are mostly related to demand-oriented drivers while those of process innovations are often related to production-oriented drivers. However, it can be observed from empirical cases that there are also mutual effects between product and process innovation. The demand-oriented drivers can promote process innovation, and production-oriented drivers can still affect product innovation. For example, if there is need for increasing the range of products such as new fermented salmon or sushi salami; the company might have to enhance productivity by introducing new automating technologies. It shows that new products possibly require new production methods.

Another example is when the business purpose is to reduce the transportation and energy costs as well as to increase production capacity and improve the flexibility of logistics, this could come with product innovations such as slowly matured salmon whose maturity can be controlled in the right timing manner for processing and delivering. In this case, production-oriented incentives are the cause for occurrence of new products.

Besides demand and supply-side drivers, policy-oriented drivers are believed to have effects on the product and process innovations. The government may introduce some positive or negative incentives to firms for environmental protection and employee HSE improvement.

Ten business objective factors, which are allocated into the three aforementioned groups: demand-oriented drivers, production-oriented drivers, and policy-oriented drivers, are listed in Table 5.

Table 5:

The business objective drivers for innovation

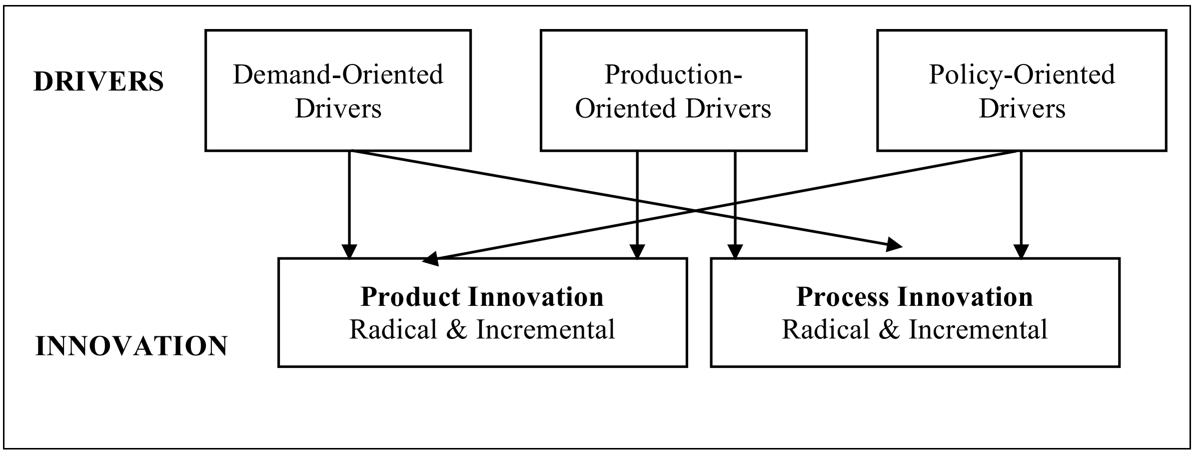
Demand-oriented Drivers	a. Increase range of products
	b. Replace outdated products or process
	c. Enter new markets or increase market share
	d. Improve quality of products
Production-oriented Drivers	e. Improve flexibility for the production
	f. Reduce unit labor cost
	g. Reduce material and energy costs per unit produced
	h. Increase capacity for production
Policy-oriented drivers	i. Reduce environmental impact
	j. Improve HSE for employees

(Source: Own illustration)

It is expected that those ten factors correlate with the four main kinds of innovation: radical product innovation, radical process innovation, incremental product innovation, incremental process innovation. Figure 11 illustrates potential relationships between the drivers and innovation types.

Figure 11:

The effect of business objective drivers and innovation types.



(Source: Own illustration)

Noticeable, besides the innovation types whether it is about product or process, the novelty of innovation concerning their influencing factors should also be considered. Some firms decide to be “first-movers” with the forefront of new technologies and innovations while others prefer being the followers with the adoption of precedently successful developments. The management strategy if being the first mover or the follower accordingly concerns strategies to invest in radical or in incremental innovations.

Once investing in radical innovation either product or process innovation, firms need to have a long-term secure financial ability because radical innovation might take a longer time to become lucrative. Radical innovations create cutting-edge technology advantages for firms to secure leading position, but also containing high risk and costs in case that radical innovation is not accepted in the market and become failures.

Incremental innovation, on the other hand, might require a lower capital investment while firms adapt and develop based on the models or technologies well-established in the market. Most of the firms in the seafood industry are small and medium sized. Therefore, restraint ability of knowledge, capital and human resources capacity appear as major hinders for firms to invest in radical innovations. However, to a certain degree firms are still willing to invest in radical innovation when it comes to some particularly important factors. For that reason, it would be interesting to answer the question of which factors are more convincing for firms to foster radical product and process innovations.

These considerations establish the following hypotheses:

- H1: The business objective drivers [*a,b,c,d,e,f,g,h,i,j] have effects on the decision of firms introducing radical product innovation
- H2: The business objective drivers [*a,b,c,d,e,f,g,h,i,j] have effects on the decision of firms introducing incremental product innovation
- H3: The business objective drivers [*a,b,c,d,e,f,g,h,i,j] have effects on the decision of firms introducing radical process innovation
- H4: The business objective drivers [*a,b,c,d,e,f,g,h,i,j] have effects on the decision of firms introducing incremental process innovation

With:

- a = Increase the range of products
- b = Replace outdated products or process

- c = Enter new markets or increase market share
- d = Improve quality of products
- e = Improve flexibility for the production
- f = Reduce unit labour cost
- g = Reduce material and energy costs per unit produced
- h = Increase capacity for production
- i = Reduce environmental impact
- j = Improve HSE for employees

The hypotheses test the relationship between the business objective drivers and innovation strategies that, if firms perceive that driver is important, whether they tend to invest more in the specific innovation form. The hypotheses are believed to provide a specific answer on which drivers are the significant focus for innovation strategies.

CHAPTER V: DATA AND METHODS

In Chapter IV, the hypotheses for examining the relationship between the business objective drivers and innovation strategies have been discussed, based on the fundamental knowledge of existing theories and empirical evidences in innovation research. Following that, Chapter V introduces the research methods, data and measures to perform the analyses.

5.1 RESEARCH DESIGN

On the purpose of confirming whether there exists the correlation between the business objective drivers and innovation activities, an econometric analysis is the primary method in this thesis. The quantitative analysis result comes from an online email survey carried out among Norwegian seafood firms. For proper hypothesis formulation, empirical observations on specific phenomena have been combined with the quantitative analysis. Existing works of literature from academics and reports from Norwegian Seafood Council, Nofima, SINTEF, Fiskerdirektoratet are also highly useful secondary sources for practical understanding about the context.

The survey was conducted by iProcess Innovation of the University of Stavanger in 2016, sent online via emails to 206 companies in the Norwegian seafood industry. The firms locate in 11 counties throughout Norway, from the north to the south, including Finmark, Troms, Nordland, Nord-Trøndelag, Sør-Trøndelag, Møre og Romsdal, Sogn og Fjordane, Hordaland, Rogaland, Oppland, Aust Agder. Among them, Troms, Nordland, Møre og Romsdal, and Hordaland are the four counties with the highest number of surveyed companies located. The sample consists of firms from four different categories, including supplying, fish processing, fisheries and fish farming. More than two third of the sample (146 of 206) are small-size companies with less than 50 employees, while 53 of 206 are medium-size with 51-250 employees, and only eight are large-size with more than 250 employees. It reflects closely the actual situation of the Norwegian seafood industry with a majority of the industry being small and medium sized firms.

The response rate of the survey is approximately 80% (164 full answers). Uncompleted answers have been sorted out to ensure unbiased analysis results. Direct participants in the survey are mostly the company representatives as directors or business leaders (171 in 206). In 206 surveyees, 116 have worked for the companies more than 11 years, and 61 of them have worked at least 3 to 10 years. It implies that those respondents have good observations and understanding of the company activities. Around 83% of the sample (171 respondents) was directly involved either much (i stor grad) or very much (i svært stor grad) in innovation process of the companies.

The survey questionnaire comprises four parts: The first part collects general information about the company, its human resources, and its competitiveness strategies; the second investigates firm characteristics in terms of innovation activities; the third concerns the drivers and barriers to the innovation of firms; the fourth studies collaboration firms have with other partners in the innovation system. The survey concentrates on activities in the period between 2014-2016. This thesis is particularly interested in the third part of the survey regarding the drivers and innovation characteristics.

5.2 VARIABLES AND MEASURE

5.2.1 Dependent variables

The four main dependent variables in this research are radical product innovation, incremental product innovation, radical process innovation and incremental process innovation. Assumingly, those definitions and concepts of innovations are not so familiar to the firms, the survey formulated the questions in a more straightforward way for firms to perceive. The questions regarding the four innovation types are:

(1) Radical process innovation: 'Har selskapet tatt i bruk metoder eller prosesser for produksjon eller leveranse av produkter i løpet av de tre siste årene som var nye for markedet' (Has the company applied methods or processes for the production or delivery of products that were new for the market during the last three years?)
(2) Incremental process innovation: 'Har selskapet tatt i bruk metoder eller prosesser for produksjon eller leveranse av produkter i løpet av de tre siste årene som var nye for selskapet' (Has the company applied methods or processes for the production or delivery of products that were new for the company during the last three years?)
(3) Radical product innovation: 'Har selskapet lansert varer eller tjenester på markedet i løpet av de tre siste årene som var nye for markedet' (Has the company launched goods or services on the market that were new for the market during the last three years?)
(4) Incremental product innovation: 'Har selskapet lansert varer eller tjenester på markedet i løpet av de tre siste årene som var nye for selskapet' (Has the company launched goods or services on the market that were new for the company during the last three years?)

The dependent estimators are binary variables with value by 0 and 1. In that, the variables take value 1 if the company answer is that it has conducted the product/process radical/incremental innovation activity in the last three years, and 0 otherwise.

5.2.2 Independent variables

The independent variables indicate the business objective drivers which are expected to have significant effects on the dependent variables. The survey listed the potential factors and asked the company how important these factors are to them. These independent variables are qualitative and ordinal-scale data.

The ten driving factors were asked with the beginning as "Hvor viktig var følgende for selskapet i perioden 2014-2016?" (How important was the following strategy for the company in the period 2014-2016?) and according to that, the ten drivers are mentioned in combination

1. Utvide spekter av varer eller tjenester (Expand the range of goods or services)
2. Erstatte utdaterte produkter eller prosesser (Replace outdated products or processes)
3. Gå inn i nye markeder eller øke markedsandel (Enter new markets or increase market share)
4. Forbedre kvalitet på varer eller tjenester (Improve quality of goods or services)
5. Forbedre fleksibilitet for produksjon av varer og tjenester (Improve flexibility for the production of goods and services)
6. Øke kapasitet for produksjon av varer og tjenester (Increase capacity for production of goods and services)
7. Redusere arbeidskostnader per produsert enhet (Reduce labor costs per unit produced)
8. Redusere material- og energikostnader per produsert enhet (Reduce material and energy costs per unit produced)
9. Redusere miljøeffekter (Reduce environmental impacts)
10. Forbedre HMS for ansatte (Improve HSE for employees)

The independent variables are measured by a six-point scale, corresponding to the degree of importance the company regard those factors to have in their innovation strategies:

1. Svært viktig (Very important),
2. Nokså viktig (Important),
3. Hverken/ eller (Neutral/ Neither)
4. Lite viktig (Somewhat important)
5. Svært lite viktig (Not important)

6. Ikke relevant (Not relevant)

One full question (translated into English), for example, is:
Question: How important was the following strategy for the company in the period 2014-2016? - Expand the range of goods or services
Answer: (1) Very important, (2) Important, (3) Neutral/ Neither, (4) Somewhat important, (5) Not important, (6) Not relevant.

Respondents will choose one of the multiple options. In order to reduce the number of variables, some of the scales were grouped according to their similarity in meaning.

- Very important (1) and Important (2) were grouped and re-coded to be equal 1 if the company believes that the driving factor is important or very important to them, equal to 0 otherwise.
- Neutral (3) and Somewhat important (4) were grouped and re-coded to be equal 1 if the company answers that that factor is neutral or somewhat important to them, equal to 0 otherwise.
- Not important (5) and Not relevant (6) were grouped and re-coded to be equal 1 if the company considers that that factor is not important or not relevant to their innovation strategies, equal to 0 otherwise.

Table 6 describe the variables and their definitions.

Table 6:
Definition of variables

Variable name	**Description**
EXPPRO_1	1 if 'Expand the range of goods or services' is important or very important; 0 otherwise
EXPPRO_2	1 if 'Expand the range of goods or services' is neutral or somewhat important; 0 otherwise
EXPPRO_3	1 if 'Expand the range of goods or services' is not important or not relevant; 0 otherwise
REPRO_1	1 if "Replace outdated products or processes" is important or very important; 0 otherwise
REPRO_2	1 if "Replace outdated products or processes" is neutral or somewhat important; 0 otherwise
REPRO_3	1 if "Replace outdated products or processes" is not important or not relevant; 0 otherwise

NEWMAR_1	1 if "Enter new markets or increase market share" is important or very important; 0 otherwise
NEWMAR_2	1 if "Enter new markets or increase market share" is neutral or somewhat important; 0 otherwise
NEWMAR_3	1 if "Enter new markets or increase market share" is not important or not relevant; 0 otherwise
IMPQUA_1	1 if "Improve quality of goods or services" is important or very important; 0 otherwise
IMPQUA_2	1 if "Improve quality of goods or services"" is neutral or somewhat important; 0 otherwise
IMPQUA_3	1 if "Improve quality of goods or services" is not important or not relevant; 0 otherwise
IMPFLEX_1	1 if "Improve flexibility for the production of goods and services" is important or very important; 0 otherwise
IMPFLEX_2	1 if "Improve flexibility for the production of goods and services" is neutral or somewhat important; 0 otherwise
IMPFLEX_3	1 if "Improve flexibility for the production of goods and services" is not important or not relevant; 0 otherwise
REDLAB_1	1 if "Reduce labor costs per unit produced" is important or very important; 0 otherwise
REDLAB_2	1 if "Reduce labor costs per unit produced" is neutral or somewhat important; 0 otherwise
REDLAB_3	1 if "Reduce labor costs per unit produced" is not important or not relevant; 0 otherwise
REDMAR_1	1 if "Reduce material and energy costs per unit produced" is important or very important; 0 otherwise
REDMAR_2	1 if "Reduce material and energy costs per unit produced" is neutral or somewhat important; 0 otherwise
REDMAR_3	1 if "Reduce material and energy costs per unit produced" is not important or not relevant; 0 otherwise
INCCAP_1	1 if "Increase capacity for production of goods and services" is important or very important; 0 otherwise
INCCAP_2	1 if "Increase capacity for production of goods and services" is neutral or somewhat important; 0 otherwise
INCCAP_3	1 if "Increase capacity for production of goods and services" is not important or not relevant; 0 otherwise
REDENV_1	1 if "Reduce environmental impact" is important or very important; 0 otherwise
REDENV_2	1 if "Reduce environmental impact" is neutral or somewhat important; 0 otherwise
REDENV_3	1 if "Reduce environmental impact" is not important or not relevant; 0 otherwise
IMPHSE_1	1 if "Improve HSE for employees" is important or very important; 0 otherwise
IMPHSE_2	1 if "Improve HSE for employees" is neutral or somewhat important; 0 otherwise
IMPHSE_3	1 if "Improve HSE for employees" is not important or not relevant; 0 otherwise
RADPROC	1 if the company has any radical process innovation activities in 2014-2016; 0

	otherwise
INCPROC	1 if the company has any incremental process innovation activities in 2014-2016; 0 otherwise
RADPROD	1 if the company has any radical product innovation activities in 2014-2016; 0 otherwise
INCPROD	1 if the company has any incremental product innovation activities in 2014-2016; 0 otherwise

(Source: Own illustration)

5.2.3 Data analysis and models

First, descriptive analysis will be performed to provide understanding about characteristics of the sample. After that, inferential analysis will be carried out to confirm or reject the hypotheses. The model predicts that if the company considers a driving factor important, whether it will be more or less likely to foster innovation. It presumes that different drivers may have an impact on different types of innovation. Thus, the four variables representing: radical product innovation, incremental product innovation, radical process innovation, incremental process innovation have been studied, instead of one generic variable innovation.

The dependent variables are binary and coded as 1 or 0 (equal 1 if the company has introduced that kind of innovation activity in the last three years, and equal 0 otherwise). In other words, the decision of the firm whether it has innovated is either yes or no. The chosen analysis technique in this research is logit regression.

The logit model indicates that:

$$y_i = \begin{cases} 1 \; if \; the \; firm \; implemented \; the \; innovation \; activity \; during \; last \; three \; years \\ 0 \quad otherwise \end{cases}$$

i=1,…n

i is the observations (the surveyed company)

n is the number of observations (164 full respondents)

The probability that a specific surveyed company has implemented the innovation activity in the last three years is measured by:

$$P_{1i} = \mathrm{P}\ (y_i = 1|X) = \frac{e^{V_i}}{1+e^{V_i}} \qquad (1)$$

and the probability that a specific surveyed company has NOT implemented the innovation activity in the last three years is measured by:

$P_{0i} = \mathrm{P}\ (y_i = 0|X) = \frac{1}{1+e^{V_i}}$ (2)

Where $V_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2$ (3)

The equation (3) is estimated by the dependent variables (types of innovation) and the independent variables (innovation drivers). This equation does not define the percentage of propensity the company would implement the innovation activity but, instead, can only showcase how innovation activities are correlated to the drivers. In this context, the equation 3 is these below four models, corresponding to the four different dependent variables:

RADPROD = β_0 + β_1 EXPPRO_1+ β_2 EXPPRO_2 + β_3 REPRO_1+ β_4 REPPRO_2+ β_5NEWMAR_1 + β_6 NEWMAR_ 2 +β_7 IMPQUA_1+β_8 IMPQUA_2+β_9 IMPFLEX_1 +β_{10}IMPFLEX_2 + β_{11} REDLAB_1 + β_{12}REDLAB_2 + β_{13}REDMAR_1 + β_{14} REDMAR_2 +β_{15}INCCAP_1 + β_{16} INCCAP_2 + β_{17} REDENV_1 + β_{18} REDENV_2 + β_{19} IMPHSE_1 + β_{20}IMPHSE_2

INCPROD = β_0 + β_1 EXPPRO_1+ β_2 EXPPRO_2 + β_3 REPRO_1+ β_4 REPPRO_2+ β_5NEWMAR_1 + β_6 NEWMAR_ 2 +β_7 IMPQUA_1+β_8 IMPQUA_2+β_9 IMPFLEX_1 +β_{10}IMPFLEX_2 + β_{11} REDLAB_1 + β_{12}REDLAB_2 + β_{13}REDMAR_1 + β_{14} REDMAR_2 +β_{15}INCCAP_1 + β_{16} INCCAP_2 + β_{17} REDENV_1 + β_{18} REDENV_2 + β_{19} IMPHSE_1 + β_{20}IMPHSE_2

RADPROC = β_0 + β_1 EXPPRO_1+ β_2 EXPPRO_2 + β_3 REPRO_1+ β_4 REPPRO_2+ β_5NEWMAR_1 + β_6 NEWMAR_ 2 +β_7 IMPQUA_1+β_8 IMPQUA_2+β_9 IMPFLEX_1 +β_{10}IMPFLEX_2 + β_{11} REDLAB_1 + β_{12} REDLAB_2 + β_{13}REDMAR_1 + β_{14}REDMAR_2 +β_{15}INCCAP_1 + β_{16} INCCAP_2 + β_{17} REDENV_1 + β_{18} REDENV_2 + β_{19} IMPHSE_1 + β_{20}IMPHSE_2

INCPROC = β_0 + β_1 EXPPRO_1+ β_2 EXPPRO_2 + β_3 REPRO_1+ β_4 REPPRO_2+ β_5NEWMAR_1 + β_6 NEWMAR_ 2 +β_7 IMPQUA_1+β_8 IMPQUA_2+β_9 IMPFLEX_1 +β_{10}IMPFLEX_2 + β_{11} REDLAB_1 + β_{12}REDLAB_2 + β_{13}REDMAR_1 + β_{14} REDMAR_2 +β_{15}INCCAP_1 + β_{16} INCCAP_2 + β_{17} REDENV_1 + β_{18} REDENV_2 + β_{19} IMPHSE_1 + β_{20}IMPHSE_2

The variables considered as "Not important or Not relevant" (EXPPRO_3, REPRO_3, NEWMAR_3, IMPQUA_3, IMPFLEX_3, REDLAB_3, REDMAR_3, INCCAP_3, REDENV_3, IMPHSE_3) have been eliminated from the model to avoid the 'dummy trap', the perfect collinearity, which may strongly lead to a biased estimator.

Logit regression also allows to find the product of all the probabilities over all the company observations, providing standard logistic distribution. The Maximum Likelihood Function for the model is:

$$L = \prod_{i=1}^{n} {P_{1i}}^{y_i} \, {P_{0i}}^{1-y_i}$$

The function can also be represented under logarithm form called Log-Likelihood Function:

$$\mathcal{L} = \sum_{i=1}^{n} \{y_i \log(P_{1i}) + (1 - y_i)\log(P_{0i})\}$$

CHAPTER VI: ANALYSIS AND FINDINGS

Chapter V has introduced the design of analysis methods and data. In Chapter VI, results and findings from descriptive and quantitative analysis concerning firm characteristics, the four main innovation types and the drivers will be discussed.

6.1 DESCRIPTIVE ANALYSIS

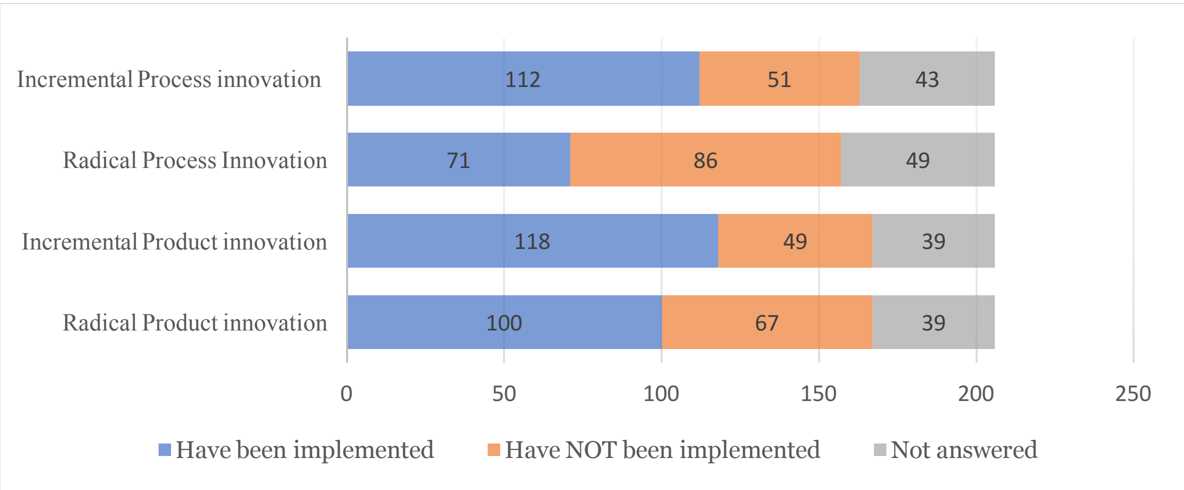
An investigation of descriptive analysis should be beneficial to provide various perspectives of the sample characteristics to explain how the innovating behaviors of Norwegian seafood companies are characterized by differences in firm segments, locations, and sizes. Descriptive statistics also serves as the fundamental base for further elaboration in the following inferential analysis.

6.1.1 Innovation types in summary

The sample includes 206 companies in the Norwegian seafood industry. Figure 12 illustrates whether 206 Norwegian seafood firms have or have not implemented the four innovation kinds between 2014 and 2016. More than half of the firms in the sample have implemented radical product innovation, incremental product innovation, and incremental process innovation (100, 118, 112 companies, respectively), while radical process innovation has been conducted by a fewer number of firms (71 companies).

Figure 12:

The summary of innovation types in Norwegian seafood firms during 2014-2016



(Source: Own illustration)

Focusing on the answer of the innovations "have been implemented," Figure 13 showcases the percentages of the four innovation types which were applied during this period. According to the statistics, incremental innovation was more preferred than radical innovation, accounting for the major share of 57%, compared to 43% of radical innovation.

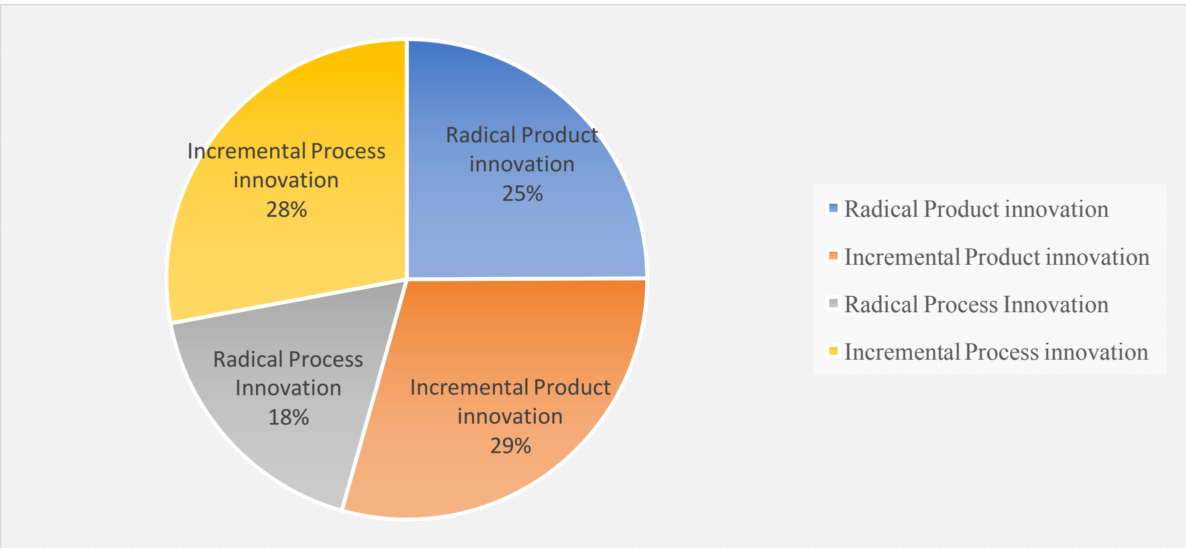
Incremental product innovation (29%) is the most popular form of innovation which was introduced by the surveyed companies from 2014 to 2016. Perhaps, it reflects closely the phenomena that innovation activities in this industry are significantly driven by the demand-side factors which often results in incremental product innovation.

Following incremental product innovation, incremental process innovation with 28% also appears as the second significant contributor to the industrial innovativeness. This trend demonstrates what was mentioned earlier that the Norwegian seafood industry has been actively improving production methods and equipment, making use of robotics, automation or advanced biotechnologies since the last decade.

Radical innovations, which require a higher capital investment and contain higher risks, have been less favored by the surveyed seafood firms. While radical product innovation is still responsible for 25%, radical process innovation with 18% is the least significant one among the four innovation types in the context.

Figure 13:

The percentage of the four innovation types during 2014-2016



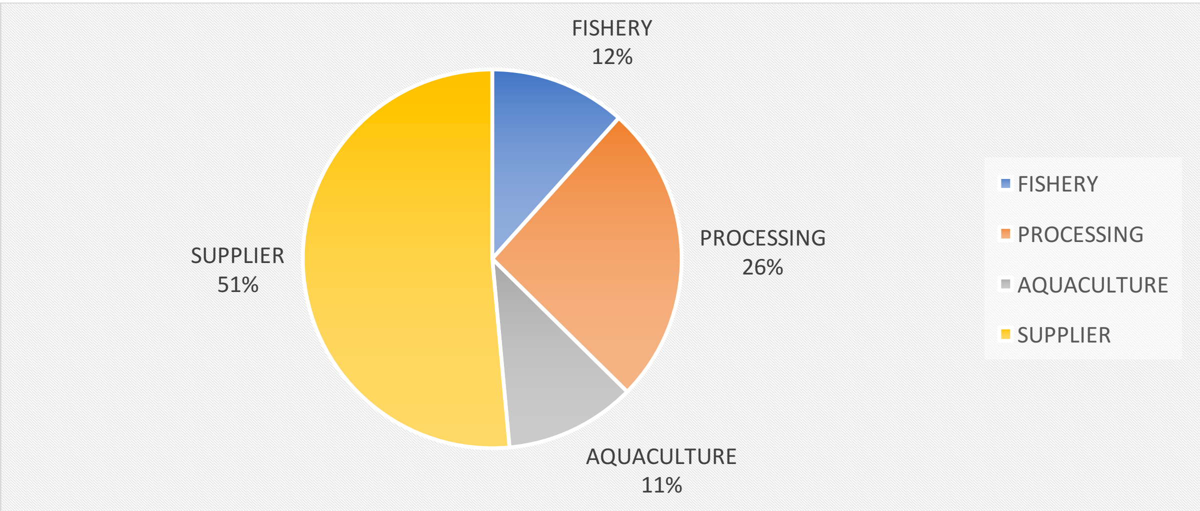
(Source: Own illustration)

6.1.2 Innovation types by segments

The previous parts explain the Norwegian seafood value chain and its innovation activities. This part continues to elaborate the understanding about innovativeness of the surveyed firms distinguished by their value chain segments. The sample consists of firms from the four sectors: fishery, aquaculture, processing and supplying. About half of the sample (51%) is suppliers of fishing and farming equipment, feeding materials, technique solutions, fish medicines, biotechnologies. Following that is the fish processors with approximately 26% of the total surveyed companies. Fishery and aquaculture companies account for substantially smaller shares with 12% and 11%, respectively.

Figure 14:

Surveyed firms by segments

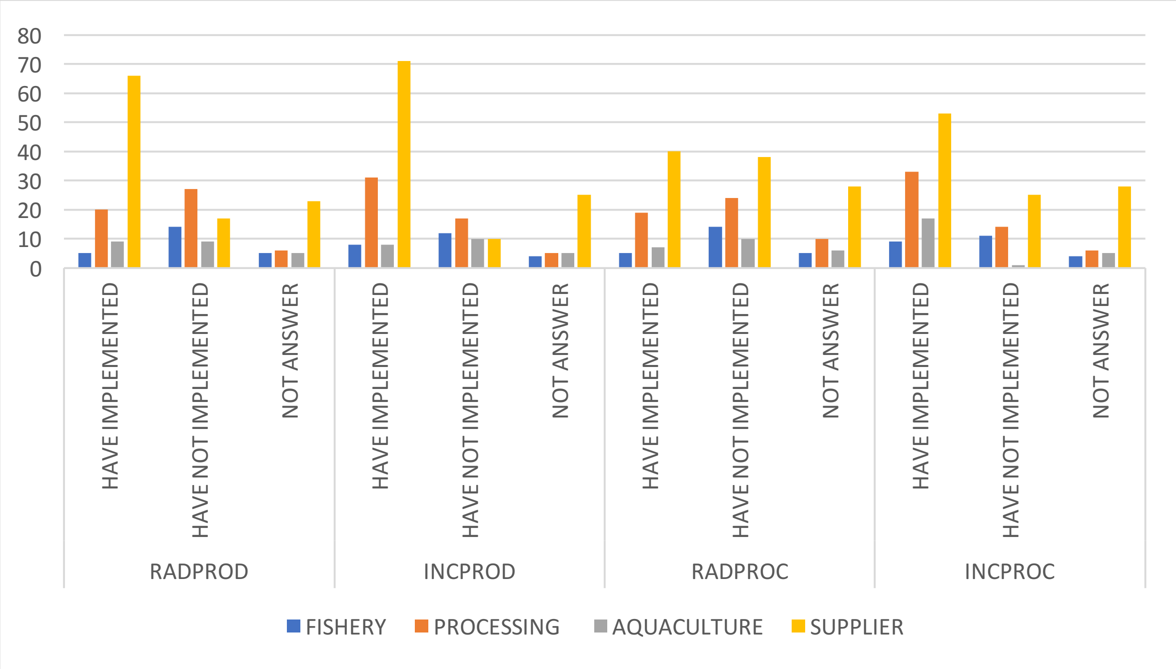


(Source: Own illustration)

Figure 15 outlines the innovation patterns characterized by the firm's sectors. Following that, fishery firms appeared not so much interested in all the four kinds of innovation. Firms in the aquaculture sector had the tendency to foster incremental process innovation. Regarding processing firms, incremental process innovation and incremental product innovation are of their primary interests. Lastly, supplying firms facilitated all kinds of radical and incremental, product and process innovation.

Figure 15:

Innovation types by firm segments during 2014-2016.



(Source: Own illustration)

Figure 16 allows us to understand which innovation types are more popular in the specific sectors. To avoid biases due to imbalanced distributions of sectors (e.g., the supplying sector accounts for a too large number of observations in the sample), the percentage of innovativeness has been considered. This indicator is measured by dividing the number of firms in the segment having implemented that innovation for the total number of companies in that segment.

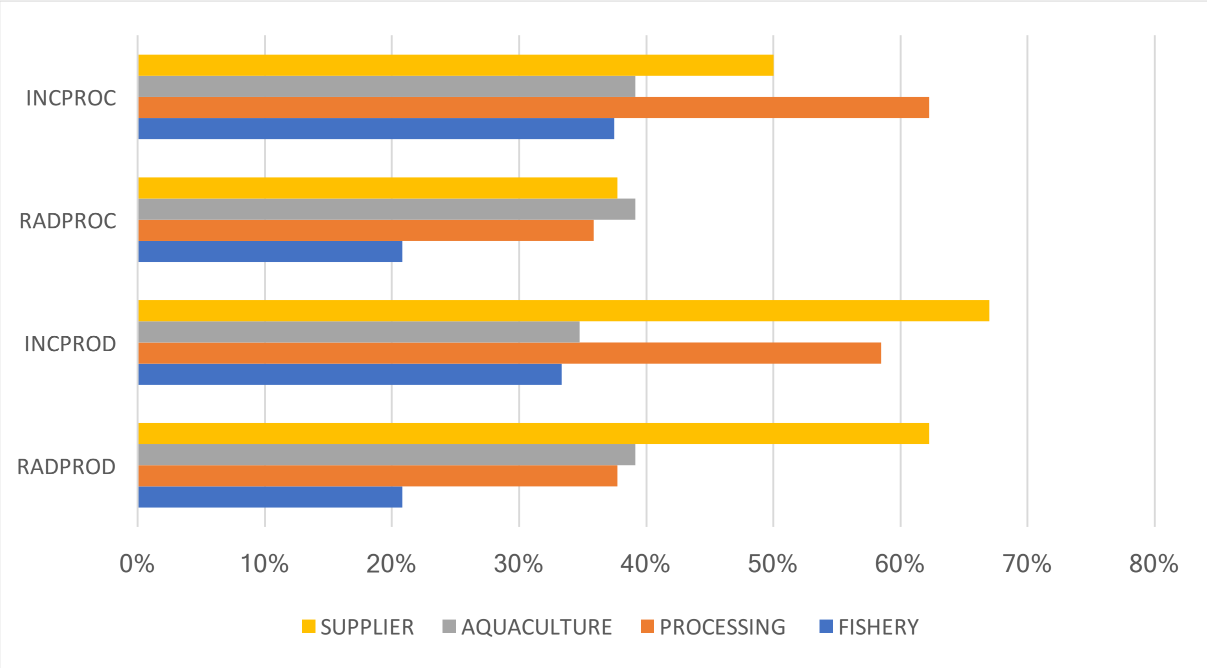
According to the figure, the supplier sector appears to be the most active sector in the industry with the largest proportions in both the radical and incremental product innovations. Products of the supplying sector are equipment, technologies, and services for other fishing, farming, and processing firms. Hence, the technological development carried out by the suppliers strongly impacts the level of innovativeness of the whole industry.

While the percentage of incremental product innovation among the supplying companies is 67% (which means that 67 in every 100 supplying companies have implemented the incremental product innovation), that of processing firms is 58%, which ranks the second. Processing firms are also the most active one in incremental process innovation with the highest percentage (62%). This tendency demonstrates that the processing companies are highly likely to make improvements or modifications in production methods and product features, assumingly, due to effects from both the demand and the supply sides. This fact has been mentioned in the previous studies. On the demand side, consumers demand more varieties of processed fish products with added-in values or product features. On the supply side, productivity and cost efficiency is one of the most critical drivers for firms in this sector to enable incremental process innovation.

When it comes to radical process innovation, all the four sectors have considerably low involvement with around 21-39%. This might be because radical process innovations are resource-intensive. Therefore, firms find it a barrier to investing in this form of innovation.

Figure 16:

The percentages of implemented innovations by firm segments during 2014-2016



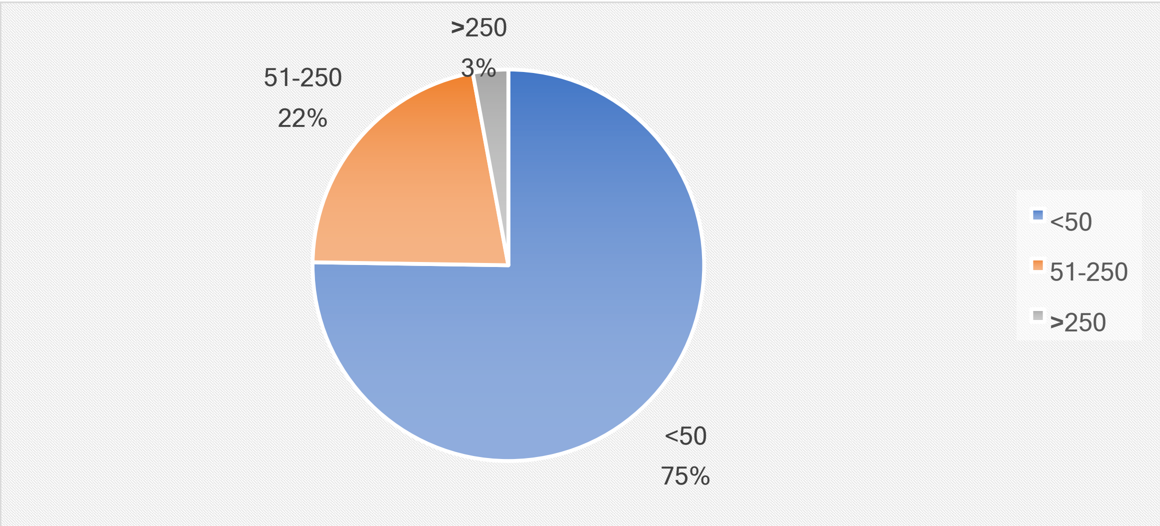
(Source: Own illustration)

6.1.3 Innovation types by firm sizes

Firm size is one of the most important characteristics. In the prediction that innovation processes may also be different for firms with unalike sizes, the following descriptive statistics give ideas about innovativeness in small, medium and large firms. In this thesis, employee number is the focused measure for the firm size. Firms with under 50 employees are considered as the small firms, while ones with 51-250 employees are the medium, and firms with more than 250 employees are large. Small companies account for the most considerable part with more than three-fourths of the total observations. The medium companies constitute 22%, and the large firms only 3% of the sample.

Figure 17:

Surveyed firms by sizes (the number of employees)

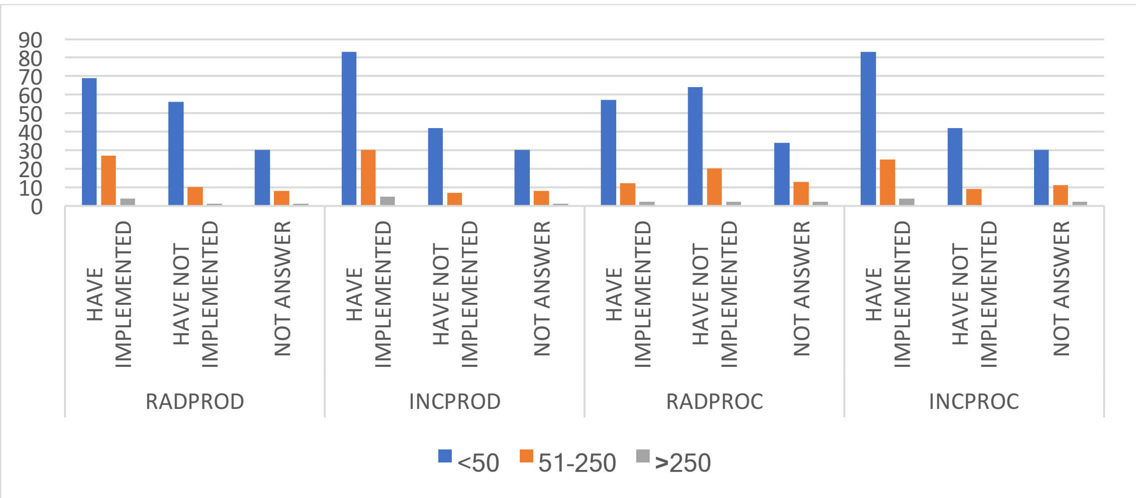


(Source: Own illustration)

Figure 18 showcases the patterns of innovation implementation by firms from the three sizes. From 2014 to 2016, small firms in the industry were likely to invest in product innovations but not much in process innovations. The pattern is also similar to the medium firms. By contrast, large companies have introduced all four kinds of innovation during the same period.

Figure 18:

Innovation types by firm sizes during 2014-2016



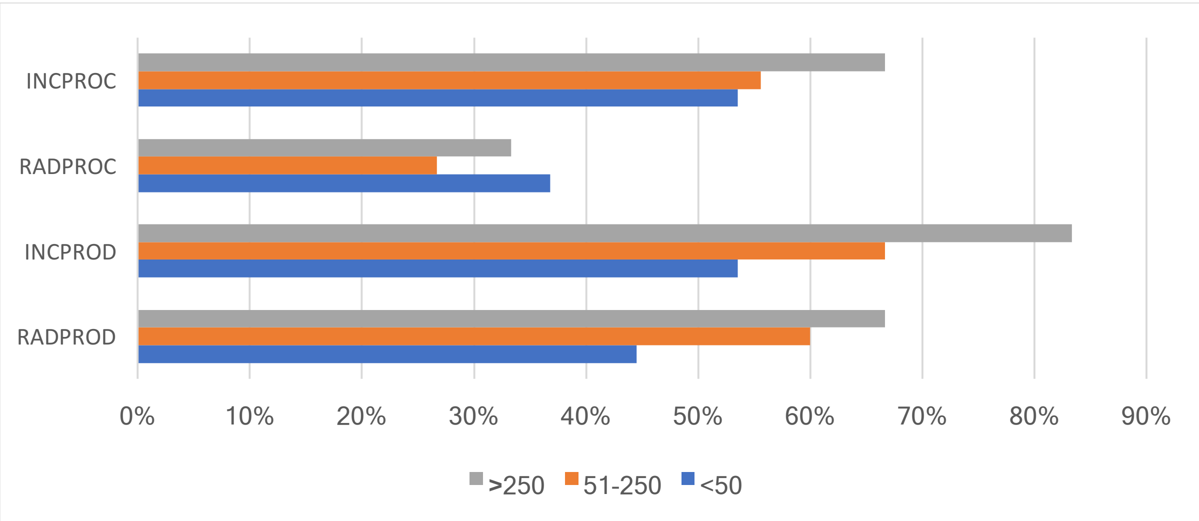
(Source: Own illustration)

Similar to the previous part, percentages to measure the innovativeness of the firms by sizes have been placed into consideration. For example, the percentage of small firm innovativeness is calculated by dividing the number of small firms having answered 'have implemented' that innovation for the total number of small firms. By that, the disproportion of the distributions of firms in the sample would be compensated.

Figure 19 indicates an interesting point that although the number of innovations implemented by the large firms in the sample is low because large firms only account for a minority of the sample, the innovativeness percentage of large firms are significantly higher than small and medium firms. Noticeably, more large firms invest in incremental product and process innovation than small and medium firms do. The statement is also true to radical product innovation as this innovation form may require a more larger resource of capital and employee talents where large firms have advantages.

Figure 19:

The percentages of implemented innovations by firm sizes during 2014-2016



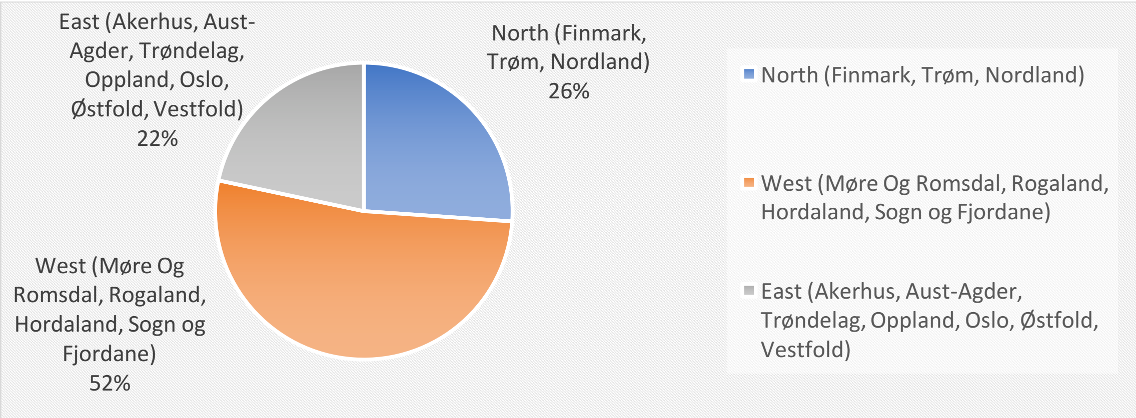
(Source: Own illustration)

Innovation types by locations

With the assumption that innovating behaviors may be differentiated by innovation clusters, firms in the sample are studied with respect to their location characteristics. Figure 20 shows the distribution of surveyed companies clustered by their locations. 206 firm observations are grouped into three groups: North Norway (Finnmark, Trøms, Nordland), West Norway (Møre og Romsdal, Rogaland, Hordaland, Sogn og Fjordane), East Norway (Akerhus, Aust-Agder, Trøndelag, Oppland, Oslo, Østfold, Vestfold). A majority of the sample, 50%, are companies from West Norway. The number of firms from the Northern and Eastern parts are almost equal with 26% and 22% respectively.

Figure 20:

Surveyed firms by locations

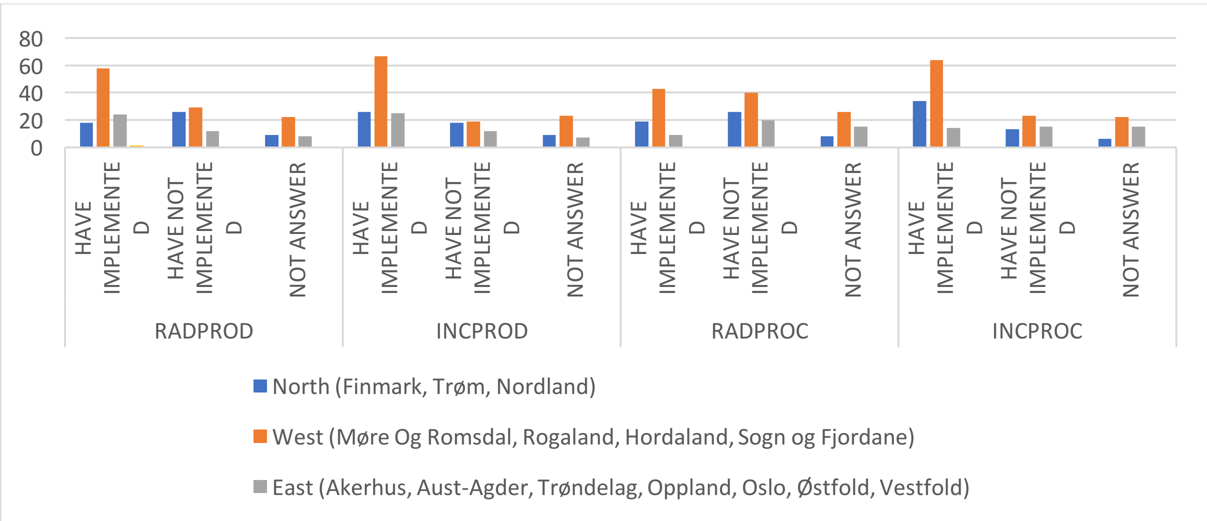


(Source: Own illustration)

According to Figure 21, firms from North Norway tended not to foster radical product and radical process innovation, but incremental product and process innovation. On the other hand, firms from the western part answered in the survey that they had implemented all four innovation types. When it comes to firms from the eastern part, product innovations regardless of the degree of novelty are their central interest while radical and incremental process innovations are not.

Figure 21:

The innovation types by firm locations during 2014-2016

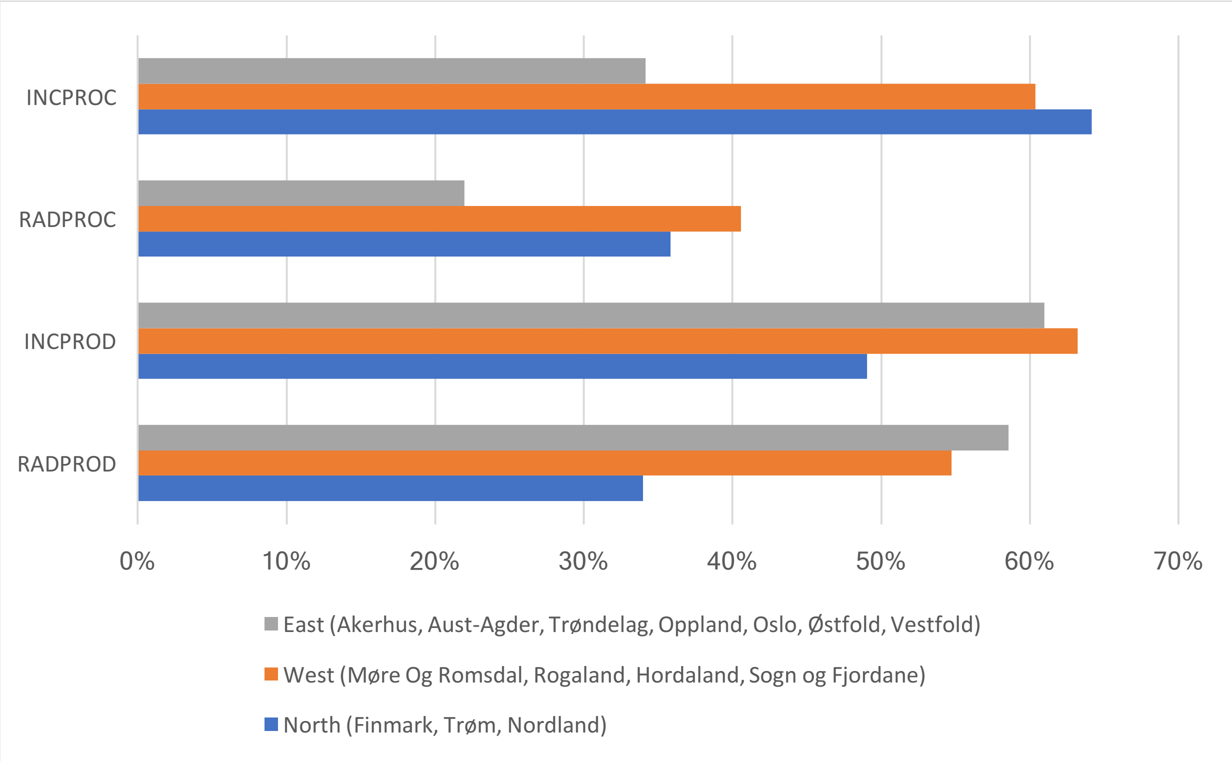


(Source: Own illustration)

Analogous to the measure in the analysis above, Figure 22 represents the percentage of innovation, which is calculated by dividing the number of firms in the cluster which have implemented that innovation for the total number of firms in that cluster. There is clear distinction in the innovation patterns between the three clusters. Firms from the western part are responsible for the highest innovativeness percentage of radical process innovation and incremental product innovation, while firms in the eastern part were more likely to introduce radical product innovation. When it comes to incremental process innovation, firms from the north has the highest proportion of this kind of innovation.

Figure 22:

The percentages of implemented innovations by locations during 2014-2016



(Source: Own illustration)

6.2 INFERENTIAL ANALYSIS

In the previous part of the thesis, the hypotheses to examine the correlation between the four innovation types and drivers are formed. In this session, findings of the inferential analysis are presented for the decision of whether to confirm or reject the formulated hypotheses.

6.2.1 Radical product innovation

The relationship between radical product innovation and the drivers are tested under the hypothesis:

H1: The business objective drivers: (a) EXPRO (b) REPOUT (c) NEWMAR (d) IMQUA (e) IMPFLEX (f) REDLAB (g) REDMAR (h) INCCAP (i) IMPENV (j) IMPHSE	have effects on the decision of firms introducing radical product innovation

Table 7 presents results of the logit regression to examine the correlation between the radical product innovation in respect of ten different driving factors. The two variables 'EXPRO_1' and 'REPOUT_1' are positively correlated with radical product innovation. Those variables with the P-value of 0.003 (EXPRO_1) and 0.035 (REPOUT_1) are also highly significant at the significant level of 1% and 5% respectively. In other words, when the company perceives that factors of 'Expanding the range of goods and services' and 'Replacing outdated products or services' as important or very important, the company is more likely to implement radical product innovation.

Another driver in the group 'Demand-driven factors' is 'NEWMAR_2' shows a negative relationship with the radical product innovation but significant at the lower level ($P<0.15$). The analysis result gives the meaning that when the company considers the factor 'Enter new markets or increase market share' is neutral or somewhat important, it tends not to invest in radical product innovation.

Not only the 'Demand-driven factors' have an impact, but also one of the 'Supply-driven factors' which has proven to affect this type of innovation. The explanatory variable 'REDMAR_1' and 'REDMAR_2' are positively correlated and significant. The P-value of REDMAR_2 is 0.002, highly significant at the level of 1%. This result explains that when the firm considers the factor 'Reduce material and energy costs per unit produced' is important or somewhat important, radical product innovation is likely to be introduced. In another way to say, the material cost factor has a significant impact on the decision of developing radical product innovation. When it comes to the policy-oriented factors, no significant impact of them is found on the dependent variable radical product innovation.

In brief, the hypotheses H1a, H1b, H1c, H1g are confirmed, which means that demand-oriented factors including 'Expanding range of goods and services', 'Replacing outdated goods and services', 'Entering new markets or increase market share' and production-optimization factor as 'Reducing the material and energy costs per unit produced' have significant effects on the introduction of radical product innovation.

Table 7:
The correlation between radical product innovation and the factors.

RADPROD	**MODEL 1**	**MODEL 2**	**MODEL 3**
EXPPRO_1	**3.624 *** (1.416)**	**3.859 **** (1.384)**	**3.801 **** (1.375)**
EXPPRO_2	1.432 (1.490)	1.723 (1.462)	1.725 (1.451)
REPOUT_1	**1.703 ** (0.987)**	**1.727 ** (0.920)**	**1.836 *** (0.919)**
REPOUT_2	0.917 (1.083)	1.067 (1.003)	1.180 (0.999)
NEWMAR_1	0.114 (1.368)	-0.557 (1.166)	-0.547 (1.173)
NEWMAR_2	-1.135 (1.459)	**-1.955 * (1.247)**	**-1.921 * (1.252)**
IMPQUA_1	9.534 (808.90)		
IMPQUA_2	8.852 (808.91)		
IMPFLEX_1	1.622 (2.245)		
IMPFLEX_2	1.507 (2.289)		
REDLAB_1	-1.150 (1.864)		
REDLAB_2	-0.636 (1.807)		

REDMAR_1	1.084 (1.086)	0.907 (0.691)	**1.006 **** **(0.673)**
REDMAR_2	**3.153 ***** **(1.289)**	**3.057 ****** **(0.973)**	**3.028 ****** **(0.962)**
INCCAP_1	0.456 (1.090)	1.004 (1.001)	
INCCAP_2	-0.266 (1.145)	1.094 (1.060)	
IMPENV_1	0.456 (1.090)		
IMPENV_2	-0.359 (1.548)		
IMPHSE_1	1.131 (1.226)		
IMPHSE_2	1.253 (1.270)		
CONSTANT	-15.757 (808.91)	-5.663 (1.779)	-5.268 (1.452)
P-VALUE MODEL	0.0000	0.0000	0.0000
PSEUDO R^2	0.3343	0.3343	0.2820

**** p<0.001, *** p<0.05, **p<0.10, *p<0.20
Standard errors are in the parentheses
(Source: Own illustration)

6.2.2 Incremental Product innovation

The relationship between incremental product innovation and the drivers are tested under the hypothesis:

H2: The business objective drivers:	
(a) EXPRO (b) REPOUT (c) NEWMAR (d) IMQUA (e) IMPFLEX (f) REDLAB (g) REDMAR (h) INCCAP (i) IMPENV (j) IMPHSE	have effects on the decision of firms introducing incremental product innovation

Table 8 presents the logit regression results that the variable 'EXPPRO_1' have a positive relationship with the incremental product innovation. The P-value of this variable is 0.001, making the variable of high significance at the 1% level. This result explains that when the firm considers the driving factor 'Expand the range of goods and products' as important or very important, that firm is likely to foster incremental product innovation.

The inferential analysis provides an interesting point that there are even more production-oriented than demand-oriented factors being correlated with incremental product innovation. The significant, positive relationship has been found between both independent variables 'IMPFLEX_1' (P<0.01) and 'IMPFLEX_2' (P<0.05) with incremental product innovation. This relationship between these variables means that 'Improving the flexibility for production of goods and services' will lead to the incremental product innovation regardless of being considered very important, important, somewhat important or neutral.

The variable 'REDMAR_1' with P-value 0.059 is also correlated with incremental product innovation with a moderate significance at the 10% level, incremental product innovation is not only driven by the demand but also the supply-side drivers. Incremental product innovation is also an innovation strategy for the firm to reduce the material and energy costs per unit. Regarding the policy-oriented factors, it did not show any significant effect of those variables on the variable incremental product innovation.

In summary, it confirms that hypotheses of H2a, H2e, H2g that the variables of 'Expand the range of goods and services', 'Improve flexibility for production of goods and services,' 'Reduce material and energy costs per unit' having significant effects on the incremental product innovation are true. However, the policy-oriented variables still have no significant correlation to incremental product innovation.

Table 8:

The correlation between incremental product innovation and the factors.

INCPROD	MODEL 1	MODEL 2	MODEL 3
EXPPRO_1	**3.883 **** (1.254)**	**4.031 **** (1.211)**	**3.539 **** (0.906)**
EXPPRO_2	0.845 (1.370)	1.269 (1.262)	0.863 (0.970)
REPOUT_1	-0.954 (1.069)	-1.156 (1.048)	
REPOUT_2	0.003 (1.189)	-0.341 (1.116)	
NEWMAR_1	0.703 (1.443)	0.870 (1.333)	
NEWMAR_2	0.268 (1.569)	0.284 (1.425)	
IMPQUA_1	-3.073 (2.201)	-3.000 (2.160)	-2.810 (1.820)
IMPQUA_2	-2.892 (2.463)	-2.593 (2.430)	-2.475 (2.136)
IMPFLEX_1	**5.103 ****	**5.164 ******	**4.745 ******

	(2.791)	**(1.744)**	**(1.655)**
IMPFLEX_2	**4.381 * (1.914)**	**4.612 *** (1.914)**	**4.277 *** (1.807)**
REDLAB_1	0.665 (2.692)		
REDLAB_2	0.394 (2.798)		
REDMAR_1	**-2.369 ** (1.287)**	**-2.190 ** (1.190)**	**-2.319 ** (1.230)**
REDMAR_2	-1.068 (1.412)	-1.194 (1.308)	-1.368 (1.313)
INCCAP_1	-0.059 (1.231)		
INCCAP_2	0.509 (1.285)		
IMPENV_1	0.191 (1.285)		
IMPENV_2	-0.818 (1.394)		
IMPHSE_1	-1.108 (1.798)		
IMPHSE_2	-0.461 (1.856)		
CONSTANT	-1.628 (2.476)	-2.320 (1.986)	-1.664 (1.547)
P-VALUE MODEL	0.0000	0.0000	0.0000
PSEUDO R^2	0.3421	0.3224	0.3031

**** p<0.001, *** p<0.05, **p<0.10, *p<0.20
Standard errors are in the parentheses
(Source: Own illustration)

6.2.3 Radical process innovation

The relationship between radical process innovation and the drivers are tested under the hypothesis:

H3: The business objective drivers:	
(a) EXPRO (b) REPOUT (c) NEWMAR (d) IMQUA (e) IMPFLEX (f) REDLAB (g) REDMAR (h) INCCAP (i) IMPENV (j) IMPHSE	have effects on the decision of firms introducing radical process innovation

In Table 9, the result from the logit regression explains a strong, positive correlation between the radical process innovation and the variable 'EXPRO_1'. Since the t-test of 'EXPRO_1' is 2.19, this variable is highly significant at the level of 5%. It means that when the firm considers the importance of the factor 'Extending the range of goods and services,' it is highly likely that the firm will introduce radical process innovation accordingly.

Besides the effect of the demand-oriented driver on this innovation form, the variable INCCAP_1 is proven to have its positive effect on radical process innovation. The high significance of INCCAP_1 is found with P<0.05. This finding indicates that providing the production-oriented factor "Increasing production capacity" is regarded as very important or important; there would be the propensity for implementing radical process innovation.

When it comes to the policy-oriented factors, interestingly, a negative relationship between variable "IMPHSE_1" and radical process innovation has been found. IMPHSE_1 with P-value 0.08 is moderately significant at the 10% level. This relationship between the two variables might appear as counterintuitive since when the firm consider the factor "Improving the HSE for employees" is important, it has the tendency not to introduce radical process innovation.

In conclusion, the hypotheses H3a, H3h, H3j are confirmed, giving the meaning that the factors "Expanding the range of goods and services," "Increasing capacity for production" and "Improving HSE for employees" have significant effects on the introduction of radical process innovation.

Table 9:

The correlation between radical process innovation and the factors.

RADPROC	MODEL 1	MODEL 2	MODEL 3
EXPPRO_1	**1.819 ** (0.966)**	**1.726 *** (0.839)**	**1.745 *** (0.796)**
EXPPRO_2	**1.907 ** (1.087)**	**1.661 ** (0.957)**	1.259 (0.889)
REPOUT_1	0.090 (0.832)		
REPOUT_2	-0.841 (0.949)		
NEWMAR_1	0.206 (1.110)	0.250 (0.902)	
NEWMAR_2	-1.418 (1.278)	-1.302 (1.085)	
IMPQUA_1	13.215 (1602.12)		
IMPQUA_2	12.129 (1602.12)		
IMPFLEX_1	15.447 (1163.62)		
IMPFLEX_2	16.059		

	(1163.62)		
REDLAB_1	-0.423 (1.627)		
REDLAB_2	-0.030 (1.642)		
REDMAR_1	0.181 (0.987)		
REDMAR_2	0.217 (1.082)		
INCCAP_1	1.569 (1.232)	**2.407 ***** **(1.206)**	**2.364 ***** **(1.157)**
INCCAP_2	0.998 (1.276)	1.813 (1.241)	1.694 (1.183)
REDENV_1	0.694 (1.045)	0.813 (0.823)	
REDENV_2	0.103 (1.104)	0.276 (0.905)	
IMPHSE_1	-1.880 (1.338)	**-1.892 **** **(1.094)**	**-1.621 **** **(0.927)**
IMPHSE_2	-1.076 (1.411)	-1.268 (1.147)	-1.354 (0.985)
CONSTANT	-30.553 (1980.109)	-3.065 (1.531)	-2.458 (1.416)
P-VALUE MODEL	0.0099	0.0012	0.0042
PSEUDO R^2	0.169	0.1308	0.0850

**** p<0.001, *** p<0.05, **p<0.10, *p<0.15
Standard errors are in the parentheses
(Source: Own illustration)

6.2.4 Incremental process innovation

The relationship between incremental process innovation and the drivers are tested under the hypothesis:

H4: The business objective drivers: (a) EXPRO (b) REPOUT (c) NEWMAR (d) IMQUA (e) IMPFLEX (f) REDLAB (g) REDMAR (h) INCCAP (i) IMPENV (j) IMPHSE	have effects on the decision of firms introducing incremental process innovation

In respect of incremental process innovation, the explanatory variable ‘REPOUT_1’ has proven to have a strong, positive relationship with this innovation form. ‘REPOUT_1’ has P-value 0.032, hence, is significant at the 5% level. This result shows that if the factor ‘Replacing outdated goods and products' is considered as important or very important, the firm is highly likely to foster incremental process innovation.

'REPLAB_1' and 'REPLAB_2', ones of the supply-side factors are also positively correlated with incremental process innovation. The first with P-value 0.032 is strongly significant at the 5% level, and the latter with P-value 0.093 is slightly significant at the 10% level. In other words, when the company considers the factor of 'Reducing the labor costs' from very important to somewhat important, incremental process innovation is likely to occur.

Similar to radical process innovation, a negative relationship of 'IMPHSE_1' and also 'IMPHSE_2' has been found with incremental process innovation. The variables are significant slightly at the 10% level. Therefore, it can be said that when the company considered the factor "Improving the HSE for employees" important or somewhat important, it will be less likely to foster incremental process innovation.

To sum up, the hypotheses H4c, H4f, and H4j are confirmed that the factors 'Replacing outdated goods and services', 'Reducing labor costs per unit' and 'Improving HSE for employees' have significant effects on incremental process innovation.

Table 10:

The correlation between incremental process innovation and the factors.

INCPROC	MODEL 1	MODEL 2	MODEL 3
EXPPRO_1	0.005 (0.831)		
EXPPRO_2	-0.221 (0.948)		
REPOUT_1	**1.353 **** **(0.775)**	**1.362 ***** **(0.594)**	**1.215 ***** **(0.565)**
REPOUT_2	0.611 (0.860)	0.630 (0.672)	0.495 (0.639)
NEWMAR_1	0.358 (1.080)		
NEWMAR_2	-0.470 (1.182)		
IMPQUA_1	-15.359 (2316.71)		
IMPQUA_2	-13.562 (2316.71)		
IMPFLEX_1	29.488 (3207.66)		
IMPFLEX_2	30.185 (3207.66)		
REDLAB_1	1.735 (1.682)	**2.768 ***** **(1.383)**	**2.406 ***** **(1.124)**

REDLAB_2	1.794 (1.700)	**2.646 **** **(1.377)**	**2.004 **** **(1.191)**
REDMAR_1	-0.474 (0.911)	-0.577 (0.908)	
REDMAR_2	-1.198 (1.002)	-0.987 (0.952)	
INCCAP_1	0.172 (1.056)	0.456 (0.899)	
INCCAP_2	-0.421 (1.109)	0.019 (0.948)	
REDENV_1	1.528 (1.139)	0.225 (0.903)	
REDENV_2	0.858 (1.170)	-0.475 (0.949)	
IMPHSE_1	**-3.603 **** **(2.082)**	**-2.644 **** **(1.643)**	**-2.103 *** **(1.373)**
IMPHSE_2	**-3.222 *** **(2.098)**	**-2.318 *** **(1.647)**	**-2.166 *** **(1.430)**
CONSTANT	-13.710 (2332.71)	-0.236 (1.255)	-0.393 (1.071)
P-VALUE MODEL	0.0092	0.0168	0.0025
PSEUDO R^2	0.1805	0.1169	0.0963

**** p<0.001, *** p<0.05, **p<0.10, *p<0.15

Standard errors are in the parentheses

(Source: Own illustration)

CHAPTER VII: DISCUSSION & CONCLUSION

In Chapter VI, the results of the descriptive and regression analysis have been presented. This last Chapter VII, will discuss findings from the analyses and conclude the research. The findings from the descriptive and regression analyses are summarized under the two tables below.

7.1 DISCUSSIONS

7.1.1 Descriptive analysis

Concerning the descriptive analysis, Table 11 summarizes the innovativeness characteristics of the sample observations.

Table 11:

Innovativeness characteristics of the sample

RADICAL PRODUCT INNOVATION (25%) **Most:** • Supplying • Large firms • Firms from West and East Norway **Least:** • Fishery sector • Small firms • Firms from North Norway	**INCREMENTAL PRODUCT INNOVATION (29%)** **Most:** • Supplying and Processing • Large firms • Firms from West and East Norway **Least**: • Aquaculture and Fishery sectors • Small firms • Firms from North Norway
RADICAL PROCESS INNOVATION (18%) **Most:** • Aquaculture, Supplying and Processing • Large and small firms • Firms from North and West Norway **Least:** • Fishery • Medium • Firms from East Norway	**INCREMENTAL PROCESS INNOVATION (28%)** **Most:** • Processing • Large firms • Firms from North Norway **Least:** • Fishery • Small and medium firms • Firms from East Norway

(Source: Own illustration)

Overall, the descriptive analysis from the sample can be concluded in four main points:

(1) Incremental innovations dominate over radical innovations. Product innovations outweigh process innovations.

The four innovation types ranked from the most to the least significant contribution are incremental product innovation (29%), incremental process innovation (28%), radical product innovation (25%) and radical process innovation (18%). The finding evidences that incremental innovations are still more popular forms in the Norwegian seafood industry than radical innovations. This point might reflect the fact that the Norwegian seafood industry is constituted by a majority of small and medium-size firms, so incremental innovations are more affordable and manageable than radical innovations.

Moreover, product innovations considerably outweigh process innovations, although incremental process innovations and incremental product innovations are still almost equally important (28% and 29%, respectively). Product innovations, in general, apparently appear more attractive to firms. Thus, assumingly, innovativeness in the seafood industry is more driven by the demand-oriented factors which often lead to product innovations. However, it makes sense to consider that incremental process innovation still holds a central role to the seafood industry, as much important as incremental product innovation, due to the advancement of new technologies.

(2) Supplying is the most and fishery is the least active sectors in innovation activities of the Norwegian seafood industry.

Concerning the innovativeness indicator, the descriptive findings show that the supplying sector performs greatly in almost all forms of innovation (radical product innovation, incremental product innovation, radical process innovation) while the fishery sector is the least innovative sector with respect to all the four innovation types.

It may be explained that the fishery sector is populated by mostly small firms with capital and human restraints with respect to having the capacity for fostering process innovations. Apart from that, possibly, this sector is not strongly driven by the market demand because products of the fishery sector are wild fishes which could not be changed or innovated. By contrast, supplying sector provides equipment and biotechnologies to produce the industry. The level of innovativeness in this sector must follow up with pace of the global technological development. Therefore, this sector is one of the most innovative sectors and play the role of a catalyst to leverage the degree of innovation in the seafood industry.

The processing sector is also another outstanding innovator in the industry carrying out mostly incremental product innovations as well as radical and incremental process innovations. This sector is predicted as strongly influenced by both demand and supply side factors since it must catch up with the new technologies for cheaper and more efficient production and to address the market demands.

The aquaculture sector is not the greatest performer among the four sectors. It is, however, still an effective contributor to the level of innovativeness in the industry with moderate involvement in all the four types of innovation.

(3) Large firms remain the main contributors to innovation of the industry.

From the descriptive analysis, the results show that large firms have the highest percentage of innovativeness for most of the innovation types. It means that large firms are more likely to invest in innovation activities than the others. The assumption is that large firms have better capital and human resources to be able to invest in radical innovations which offer higher competitive advantages but also contain higher risks, as well as require a longer period to become lucrative.

(4) Product innovations are attractive to firms from West and East Norway, while process innovations are dominant in firms from North Norway.

From the descriptive findings, the patterns of innovativeness differ from region to region. While firms from West and East Norway are more interested in product innovations, firms from the North tend to involve more in process innovations. An assuming explanation for this phenomenon is that the firm locations are clustered by sectors, which may characterize the innovating behaviors. For example, the region with more fish processors might have a higher demand for radical and incremental product innovations while the region with more fishery firms might not have such high demand for those two forms of product innovations. However, in order to conclude with a certain degree of rationale behind this distinction in the innovation clusters, a further research study might be required.

7.1.2 Inferential analysis

While the descriptive analysis explains the innovation characteristics of the sample, the inferential analysis illustrates the relationships between the four innovation types with the demand, supply, and policy-oriented drivers. Table 12 summarizes evidenced correlations between those variables.

Table 12:

The correlation between the drivers and the four innovation types

Drivers/ Innovation types		Radical product innovation	Incremental product innovation	Radical process innovation	Incremental process innovation
Demand-oriented	1. Expand the range of products and services	x	x	x	
	2. Replace outdated products or processes	x			x
	3. Enter new markets or increase market share	x			
	4. Improve the quality of goods or services				
Production-oriented	5. Improve flexibility for production		x		
	6. Reduce labour costs per unit				x
	7. Reduce material and energy costs per unit	x	x		
	8. Increase product capacity			x	
Policy-oriented	9. Reduce environmental impacts				
	10. Improve HSE for employees			x	x

(Source: Own illustration)

In summary, the analysis findings are concluded in the ten following points:

(1) *'Expanding the range of products and services' is a key driver to radical product innovation, incremental product innovation, and radical process innovation.*

Referring to the descriptive analysis, product innovations appears more favored than process innovation. These finding postulates that the seafood industry is driven by the demand factors. The regression analysis result has reaffirmed this claim that the factor "Expanding the range of products and services" is substantially important to the three innovation types. Previous research in similar research topic also shed lights on the empirical evidence that expanding more varieties of products are crucial to the seafood industry while the elasticity of demand in this industry is quite inelastic and strongly affected by the changes in the market demands such as preferences and incomes. Therefore, the occurrence of radical and incremental product innovations as well as radical process innovations perhaps derive from the need to address the market demands, which are also influenced by the macro and micro environmental changes.

(2) *Demand-side factors 'Expanding the range of products,' 'Replacing outdated products,' 'Entering new markets or increase market shares' play the crucial role in the introduction of radical product innovation.*

Despite the least likelihood of being implemented in the seafood industry, radical product innovation is proven to be crucial. The demand-side factors actively push this type of innovation. The three key factors 'Expanding the range of products', 'Replacing outdated products,' 'Entering new markets or increase market shares' are found to have a significant relationship with radical product innovation. When the companies consider that the two first factors are important to them, they tend to implement radical product innovation. Also, when the companies regard that factor 'Entering new markets or increase market shares' is not of much importance, radical product innovation is less likely to be implemented.

(3) *Crossed effects that demand-oriented factors have impacts on process innovation and production-oriented factors have impacts on product innovation are confirmed.*

Cross-effects between the demand-driven factors with process innovations and between supply-driven factors with product innovations have been clearly found. This finding reinforces the perspective that the modern innovation process is no longer linear but instead has become more complex and integrated. The demand factors (such as 'Expanding the range of products' and 'Replacing outdated products and process') are also the enablers for process innovation strategies. Similarly, the supply factors (such as 'Improving the flexibility of production' and

'Reducing the material and energy costs per unit produced') are the driving forces for the introduction of product innovations. Empirical observations on that phenomena also strengthen this statement that, for example, when the firm needs to extend the new range of products to attract new customers, product innovation will be fostered. Accordingly, this product innovation may require new production lines or production methods. Then, the process innovation will be introduced to address the emerging needs for production.

(4) 'Expanding the new range of products' is correlated with radical product innovation and radical process innovation, while 'Replacing outdated products' is correlated with incremental process innovation.

This statement implies that the degree of innovation novelty might be a response to the degree of requirements from the business strategy. Mentioned in part above, the driver 'Expanding the new range of products' is strongly correlated with both radical product and process innovation. It means that when the company aims at coming up with brand new products, they might need a radical product innovation and then perhaps, it might also require completely new production processes. On the other hand, 'Replacing outdated products' is not correlated with radical innovation but incremental innovation. It perhaps indicates that 'replacing outdated products' may just require some modifications in the product features, and consequently, demands some improvements or adjustments in the production process, instead of replacing it with an entirely new one.

(5) 'Reducing material and energy costs per unit' is central to radical and incremental product innovations.

Interestingly, the analyses results show that the supply-side factor also has a high impact on the implementation of product innovations. In specific, the factor 'Reducing material and energy costs per unit' has highly significant, positive relationship with both radical and incremental product innovation. This finding provides an interesting point that there may exist a great need for reducing the use of materials and energy by developing complete new or significantly improved products. This point of view is also supported by the practical case study that some new species of salmon can be fed by algae instead of traditional wild fish materials. In this case, the product innovation helps reduce a great part of material costs and energy costs for that company.

(6) 'Reducing labor cost per unit' is essential to incremental process innovation.

The analysis shows that incremental process innovation is strongly driven by the factor 'Reducing labor costs per unit.' The descriptive analysis showed that the majority of processing firms conducts incremental process innovations. Especially in the processing sector, assembly production plays an essential role, and the nature of mass production is either capital-intensive or labor-intensive. On the other side, wages in Norway are very high, so it is highly costly for Norwegian firms to choose the labor-intensive strategy. Instead, firms in the Norwegian seafood industry tend to invest in incremental process innovation, making use of automation and robotics to replace human works to reduce the labor cost per unit. By that, those firms could also attain competitive advantages over their lower cost competitors. In the case of the Norwegian seafood industry, Norway has increased the competitiveness of its seafood products significantly over the products of Chile by stimulating successfully the level of automation and robotics in production.

(7) 'Improving flexibility for production' also matters to incremental product innovation.
The factor 'Improving flexibility for production' is proven to have a positive relationship with the incremental product innovation. Reflecting this in relation to the empirical observation, the finding is also linked to the practical business context. As mentioned in parts above, 'real-time' plays a central role to the food and seafood industries due to the product perishability. The products are expected being delivered to the retailers and then to the consumers in a right amount of time so that they still reserve good quality and nutrients. Therefore, innovation for more flexible production and distribution is called for. One of the innovative solutions for improving this flexibility is incremental product innovation. This finding also highly relates to the important application of biotechnologies. The higher expectation of consumers for non-chemical, non-addictive products encourages the producers to manufacture products with better preserving techniques and biotechnologies. This is why the importance of 'Improving flexibility for production' is strongly correlated with the implementation of incremental product innovation.

(8) 'Increasing production capacity' results in the introduction of radical process innovation.
The production function is popular in previous research studies and indicates that the total quantity of production is determined by technological change multiplying the inputs of labor and capital. Technological changes can, therefore, increase production quantity and shift the supply curve accordingly upwards. This theory is wholly aligned to the finding in this research that the factor 'Increasing production capacity' has a strong, positive relationship with radical process innovation. In another way to explain this, once the firm aims at increasing the production capacity, radical process innovation is often considered as a game-changing innovation strategy to achieve the production target.

(9) No relationship between the environmental factor with innovation variables has been found.

Not any of the innovation variables can be found to have a significant correlation with the factor 'Reducing the impact on the environment.' It may be difficult to define whether this finding reflects the practical context of the industry closely. However, it has been shown in recent studies that green innovation has gained more extensive attention from the seafood firms to serve the purpose of taking responsibility for environmental protection. Moreover, the Norwegian authorities also enact increasingly policies and regulations in fish harvesting, fish farming, and fish production to ensure a sustainable ecosystem and clean environment.

(10) There is proven negative relationships between factor 'Improving HSE for employees' with both the radical and incremental process innovation.

Interestingly, the factor 'improving HSE for employees' showcases an unexpectedly negative relationship with radical and incremental process innovations. This finding may appear counterintuitive at first, but makes more sense when it is considered from the perspectives of firms. Firms in the Norwegian seafood industry are mostly small and medium sized companies whose capital may be highly restraint. To business, profit maximization is the principal goal. Firms seek for innovative solutions which can result in increasing profit in the future. Perhaps, innovations to improve HSE for the employees are not considered promisingly lucrative, and combined with firms' limited financial capacity, make it not attractive to these firms. Therefore, once firms have to spend its budget on activities for improving HSE for the employees, the plan for investment in innovation activity might be hindered accordingly. This can be a possible explanation for the negative relationship between those variables.

7.2 CONCLUSION

Findings of both descriptive and quantitative analyses have strongly justified the evidence from empirical observations. The demand-oriented factors as 'Expanding the range of goods and services,' 'Replacing outdated products or processes,' 'Enter new markets or increase market share' have proven to be correlated with innovation to a certain degree. Similarly, all the four production-oriented drivers as 'Improving flexibility for production,' 'Reducing labor costs per unit,' 'Reducing material and energy costs per unit' and 'Increasing product capacity' have also positive relationships with the four innovation types. There has been found cross-effect of demand-oriented factors on the process innovations and production-oriented factors on the product innovations. It means that innovation processes have become more complex and integrated, with the effects on forces from different sides.

The policy-oriented drivers such as 'Improving HSE for employees' appears to have a negative relationship with the process innovations. Aforementioned, this result might reflect the fact that most of the firms in the Norwegian seafood industry are small. Thus, budget division for activities could be highly restricted. For that reason, once a firm has to spend more on employee activities, accordingly, it has to spend less on innovation activities.

'Reducing environmental impact' has not been found to have a meaningful relationship with innovation in this research. However, it may appear controversial to generalize that environmental protection is not important to the Norwegian seafood industry because some empirical evidence has still shown that firms in this industry have made efforts in 'green innovations.' Therefore, to have more exact findings regarding the effect of environmental factors on innovation, a separate research study should be considered.

Presumably, the nature of policy-oriented drivers is different from that of demand and production-related factors. Possibly policy-oriented drivers are exogenous influences of the government rather than endogenous choices of the firms. Therefore, it would be interesting to continue the investigation of this topic to understand how those exogenous factors make impact on the innovation behavior of firms.

The thesis has made its best efforts to provide some further understanding of innovation and its drivers in a medium-tech industry of a well-developed country. However, it is still more research opportunities for considering the same topic but with another scenario, a developing country. Perhaps, innovation is predicted to be profoundly different in such different settings. Therefore, an empirical analysis to study the differences between the Norwegian seafood industry and a seafood industry of a developing country should be very relevant and attractive. For example, research questions such as how the industry of a developing country makes use of its resources to achieve competitive advantages, how innovation strategies might differ for a developing country and a developed country, and which drivers should be more prioritized in the developing countries would be interesting and relevant to answer.

REFERENCES

A.D. de Root (1969) Methodology: Foundations of inference and research in the behavioral sciences (Psychological studies). Mouton

Asche, F., AG Guttormsen, KH Roll and R. Tveterås (2013) Production growth, innovation and environmental challenges: Growth in Norwegian salmon farming. Social Economist ,4.

Asche, F., D. Smith D. M. (2018). Viewpoint: Induced Innovation in Fisheries and Aquaculture, Food Policy. Volume 76, 2018, Pages 1-7, ISSN 0306-9192.

Asheim, B., Grillitsch, M., Trippl, M. (2017) Chapter 4 - Smart Specialization as an Innovation-Driven Strategy for Economic Diversification: Examples From Scandinavian Regions, Advances in the Theory and Practice of Smart Specialization, Academic Press, 2017, Pages 73-97

Asheim, B. (2014) Kan Sjømatindustrien Skape Innovasjonsbaserte Konkurransefortrinn? Unpublished paper. Center for Innovation Research, University of Stavanger, Business school.

Bar, E. (2015) A case study of obstacles and enablers for green innovation within the fish processing equipment industry. Journal of Cleaner Production. vol. 90.

Bigliardi, B., Dormio A. (2009). An empirical investigation of innovation determinants in food machinery enterprises. European Journal of Innovation Management. 12. 223-242. 10.1108

Bjørndal, T. (2001). The competitiveness of the Chilean Salmon Aquaculture Industry. Center for Fisheries Economics. Discussion Paper No.7/2001

Brewin, D., Monchukm, D and Partridgem. M. (2009), Examining the Adoption of Product and Process Innovations in the Canadian Food Processing Industry, Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 57, (1), 75-97

Cantwell, J. (2005). Innovation and competitiveness. The Oxford Handbook of Innovation, page 543.

Cortesi, M., Panebianco, A., Giuffrida, A., Anastasio, A. (2009). Innovations in seafood preservation and storage. Veterinary research communications. 33 Supply 1. 15-23. 10.1007

Dohse, D., Niebuhr, A. (2017). How different kinds of innovation affect exporting, Economics Letters, Volume 163, 2018, Pages 182-185.

Earle, M.D. (1997). Innovation in the food industry. Trends in Food Science & Technology. 8. 166-175. 10.1016

Ernst & Young (2016) The Norwegian Aquaculture Analysis.

Fagerberg, J. (2005) Innovation: A guide to the Literature. The Oxford Handbook of Innovation. Oxford University Press.

FAO (Food and Agriculture Organization of the United Nations) (2016) FAO Fish Report.

FAO (Food and Agriculture Organization of the United Nations) (2013) Fishery and Aquaculture Country Profile. The Kingdom of Norway.

Fredheim, A. (2013). Drivers for innovation of cage farming seen from SINTEF – CREATE. SINTEF Fisheries and Aquaculture

Fellnhofer, K. (2017). Drivers of innovation success in sustainable businesses. Journal of Cleaner Production. 10.1016.

Ferreira, J., Fernandes C., Alves H., Raposo M. (2015). Drivers of innovation strategies: Testing the Tidd and Bessant (2009) model. Journal of Business Research. 68. 10.1016.

Fiskeridirektoratet (2016) Økonomiske og biologiske nøkkeltal frå dei norske fiskeria - 2016 / Economic and biological figures from Norwegian fisheries

Guttormsen A., G., Øystein M., and R. Tveterås, (2011) Innovations and Structural Change in Seafood Markets and Production: Special Issue Introduction. Marine Resource Economics 2011 26:4, 247-253

Hippel, E. (1988). The Sources of Innovation. New York: Oxford University Press.

Iversen, A., Brustad, T., Jahnsen, S., (2010) Innovasjon i sjømatnæringen. Nofima Rapport 24/2010

Kahn, B. K. (2018). Understanding innovation. Business Innovation (2018) 61, 453-460.

Kline S. K., Rosenberg N., (1986). An Overview of Innovation. In R. Landau and N. Rosenberg (eds.), The Positive Sum Strategy: Harnessing Technology for Economic Growth. Washington, DC: National Academy Press, 275-304.

Lazonick, W. (2005) The Innovative Firm. The Oxford Handbook of Innovation. Oxford University Press.

Lundvall, N, Å. (1998). Innovation as an interactive process: From User-Producer interaction to the National System of Innovation in Dosi et al. 1988: 349-69

Marine Harvest (2017) Salmon farming industry handbook.

Nagarajarao R., (2016). Recent Advances in Processing and Packaging of Fishery Products: A Review. Aquatic Procedia, Volume 7, Pages 201-213.

Norwegian Seafood Council (2018) Sjømatnasjonen Norge 2018 rapport.

Norwegian Seafood Council (2017) Nurturing Growth: The Norwegian Way. Report on Aquaculture in Norway 2017.

Norwegian Monitoring Program for Antibiotic Resistance in Microbes from Feed, Animal and Food (NORM-VET) (2016) Annual Report.

Norwegian Ministry of Fisheries and Coastal Affairs (2013). Fact about fisheries and aquaculture 2013.

OECD (2005), The Measurement of Scientific and Technological Activities. Proposed Guideline for Collecting and Interpreting Technological Innovation Data. Oslo Manual.

Olafsen, T. (2007) Innovation mechanisms in the Norwegian Fisheries and Aquaculture industry. SINTEF Fisheries and Aquaculture. Workshop in Akureyri 11-12 October 2007

Rajapathirana, J., Hui, Y. (2017). Relationship between innovation capability, innovation type, and firm performance. Journal of Innovation & Knowledge. 3. 10.1016.

Rosenberg, N. (1976). Perspective on Technology. New York: Cambridge University Press.

Rosenberg, N. (1982). Inside the Black Box: Technology and Economics. New York: Cambridge University Press.

Rotabakk, Bjørn (2013). Innovative technologies for seafood processing. The presentation of Nofima.

Santeramo, F., Carlucci, D., De D. B., Seccia, A., Stasi, A., Viscecchia, R., Nardone, G., (2017). Emerging trends in European food, diets and food industry. MPRA Paper 8, 2105, University Library of Munich, Germany.

Solow. M. R. (1956). A Contribution to the Theory of Economic Growth Robert M. Solow The Quarterly Journal of Economics, Vol. 70, No. 1. (Feb., 1956), pp. 65-94

Strecker, N. (2009) Innovation Strategy and Firm Performance, An empirical study of publicly listed firms. Desertation Karl-Franzens-Universität Graz, Österreich, November 2007

Schumpeter, J. (1934). The theory of economic development. Cambridge, Mass: Harvard University Press.

Taalbi, J. (2017). What drives innovation? Evidence from economic history. Research Policy. 10.1016.

Tunzelmann, N., Acha, V. (2005) Innovation in “Low-Tech” industries. The Oxford Handbook Of Innovation. Oxford University Press.

Tveterås, R. (2006) The future of fishing and the seafood industry. University of Stavanger, Norway International Fishmeal and Fish Oil Organisation. Annual Conference 2006, Barcelona, Spain.

Verlasso (2018) Fish in: fish out. Verlasso website.