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Norwegian Aquaculture 2050: A Scenario Planning Analysis

William Finne

Marine Technology
Submission date: June 2017
Supervisor: Bjørn Egil Asbjørnslett, IMT

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Preface

This thesis is a part of the Masters of Science degree in Marine Technology with specialization in marine systems design at the department of Marine Technology at the Norwegian University of Science and Technology (NTNU) in Trondheim. The workload of the thesis corresponds to 30 ECTS and have been written by one author, William Finne, 5th year student of Marine Technology, NTNU.

The intention of this thesis is to perform a scenario planning analysis for the Norwegian aquaculture industry towards 2050 using six interviews with seven relevant stakeholders of the industry as input. The individual answers of the stakeholders interviewed are not included in this report to protect the privacy of the stakeholders. Since there in one of the interviews were two participators from the same company, these two have been regarded as one entity in the analysis. I have placed the citations at the end of each paragraph to increase readability. The full problem description is included in Appendix A.4 Pre-project report.

I would like to thank my supervisor, Professor Bjørn Egil Asbjørnslett at the department of Marine Technology at NTNU for providing relevant literature and for valuable guidance during the semester. I would also like to thank my co-supervisor Hans Bjelland, Research Manager at Sintef Ocean and Centre Manager of SFI Exposed. This project would not have been possible without your initiative and support.

I would finally like to thank the stakeholders of the Norwegian aquaculture industry who participated in the interviews which has been essential for the creation of this thesis. These are:

- Snorre Jonassen, Director at Cermaq.
- Trude Olafsen, Project Manager at Aquagroup.
- Jens Christian Holm, Director at the Coast- and aquaculture-department at the Norwegian Fishery Directorate.
- Thor Hukkelås, Head of aquaculture-products at Kongsberg Maritime.
- Rune Magne Nilsen, Senior Surveyor at the cargo ship department at the Norwegian Maritime Directorate.
- Åse Waage, Deputy Director, Subdivision removable devices at the Norwegian Maritime Directorate.
- Karl Andreas Almås, Special adviser at Sintef Ocean.

Thank you,

William Finne,
Trondheim, June 6, 2017

Abstract

The objective of this thesis is to create a set of scenarios and action plans for the Norwegian aquaculture industry's development towards 2050. The purpose of doing this is to encourage the decision-makers within the industry to consider possible future scenarios that they would not otherwise and to serve as an aid towards achieving the industry's 2050-goals.

To form a basis to perform a scenario planning analysis, an individual study of the Norwegian aquaculture industry's current situation, the development of the industry since its beginning, its 2050-goals, the prerequisites to achieve the 2050-goals, a PESTEL-analysis, a competitive force analysis and a SWOT-analysis is performed. Further, to ensure the necessary input to perform the analysis, six interviews with seven relevant stakeholders of the industry are conducted.

To perform the scenario planning analysis, the SRI approach proposed by Stanford Research Institute is used. This is a qualitative method and is one of the most commonly used methods for scenario planning. The SRI approach consists of eight steps; 1) Analysing the decisions and strategic concerns, 2) Identifying the key decision factors, 3) Identifying key environmental forces, 4) Analysing the environmental forces, 5) Defining scenario logic, 6) Elaborating the scenarios, 7) Analysing the implications for key decision factors and 8) Analysing implications for decisions and strategies.

Within step 5) of the approach, a cross-impact analysis is performed to analyse the effect the different environmental forces have on each other and a morphological analysis is performed to generate plausible combinations of factor variations within the scenario themes. The resulting scenarios are created in step 6) and the action plans are created in step 7) and 8). After the scenarios have been created a validation analysis is performed to ensure that the scenarios serve as an adequate basis for decision-making. The criteria the scenarios are evaluated by are 1) Plausibility, 2) Consistency, 3) Creativity and coherence and 4) Relevance. To check for consistency, the scenarios are subjected to a consistency analysis.

The main results of this thesis work are four scenarios named Dry Well, Puddle, Ocean and Poseidon which all describe possible future states of the industry in 2050 and the development leading up to these states.

Dry Well is the worst-case scenario and describe a future where the industry experience a worsening in the situation of all the force-groups that affect the industry, where the environmental situation is the main driver. The result of the worsened situation is that the export volume from the Norwegian aquaculture industry has dropped to 150.000 tonnes in 2050.

Puddle describe a future where the industry has not managed to improve the environmental issues of the industry and therefore has lost the political will for an upscaling of the production. The result of this is that the export volume from the Norwegian aquaculture industry in Puddle has stagnated at 950.000 tonnes in 2050.

River describe a future where the industry has successfully achieved exposed aquaculture and by doing so they have eliminated the environmental issues at these locations. However, they have not improved the environmental situation at the locations near the shore and this has caused the politicians to be reluctant for upscaling at these locations. The result of this is that the export volume from the Norwegian aquaculture industry is 2.110.000 tonnes in 2050.

Poseidon is the best-case scenario and describe a future where the industry has reached all their 2050-goals. This is a ripple effect of a choice the industry made to in collaboration solve the environmental issues which became very successful. This combined with good marketing efforts and an increase in global demand has resulted in the export volume from the Norwegian aquaculture industry reaching 5.000.000 tonnes in 2050.

For each scenario, a corresponding action plan is created. These are intended to describe the implications of the scenario with respect to the key decision factors, determine whether the information about the future validate the original assumptions, determine what the scenarios imply for the design and timing of strategies, describe what threats and opportunities the scenarios suggest, describe what critical issues emerge from the scenarios, determine which cases deserve to be addressed by specific contingency plans, determine what kind of flexibility and resilience that is necessary from the industry's planning perspective and determine what factors deserve monitoring. A common denominator in the action plans is that achieving environmental sustainability should receive a higher priority if the industry is to reach the 2050-goals. Another common denominator is that the environmental issues are inhibiting the growth of the industry in all the scenarios where the industry does not achieve their 2050-goals. Therefore, all the action plans suggest that the environmental issues should be addressed by specific contingency plans.

The scenarios and action plans created fulfil the objective as they all describe possible future developments which may encourage the decision-makers presented to them to consider developments they would not have otherwise. Further, since there are many advantages associated with implementing scenario planning as part of a company's long-term strategy, doing so may enable the companies to better seize opportunities and avoid threats in the future given that they are aware of the pitfalls of using scenario planning. Therefore, since the scenarios and action plans may cause the stakeholders presented to them to see the value of implementing scenario planning, the thesis fulfils the aim of serving as an aid towards achieving the 2050-goals.

The conclusion of this thesis is that the scenarios and action plans fulfil the objective of the thesis, but that for the actors within the industry to have more use of a scenario planning analysis they should implement it as part of their own company's long-term strategy.

The recommendations for further work that would improve the quality of the analysis is to perform the whole analysis in collaboration with the involved stakeholders instead of only using them as input. For individual companies to have more use of the thesis work, the recommendation is to use this thesis as a guideline of how to perform a scenario planning analysis and to implement scenario planning as part of their own long-term strategy. Within the area of scenario planning literature, the recommendation for further work is to perform more research on the effectiveness of scenario planning as there in the literature only was found one study doing this.

Sammendrag

Formålet med denne oppgaven er å lage et sett med scenarioer og handlingsplaner for den Norske havbruksindustriens utvikling frem mot 2050. Hensikten med å gjøre dette er å oppmuntre beslutningstakerne til å betrakte mulige utviklinger de ikke ville gjort ellers og å fungere som et hjelpemiddel mot å nå industriens 2050-mål.

For å danne et grunnlag for å utføre en scenarioplanleggings-analyse har det blitt gjort en studie på den Norske havbruksindustriens situasjon i dag, dens utvikling, dens 2050-mål, forutsetningene for å nå 2050-målene, en PESTEL-analyse, en konkurransekraft-analyse og en SWOT-analyse. Videre, for å sikre nødvendig informasjon for å gjennomføre analysen har seks intervjuer med syv relevante interessenter til industrien blitt gjennomført.

For å utføre scenarioplanleggings-analysen brukes SRI metoden foreslått av Stanford Research Institute. Dette er en kvalitativ metode og er en av de mest brukte metodene for scenarioplanlegging. SRI metoden består av åtte steg; 1) Analysere avgjørelser og strategiske interesser, 2) Identifisering av viktige beslutningsfaktorer, 3) Identifisering av viktige miljøstyrker, 4) Analysering av miljøstyrkene, 5) Definering av scenario-logikker, 6) Utdyping av scenarioene, 7) Analysering av implikasjoner for beslutningsfaktorene og 8) Analysering av implikasjoner for avgjørelser og strategier.

I steg 5) av metoden gjennomføres en kryss-innvirkningsanalyse for å analysere effekten de forskjellige miljøstyrkene har på hverandre og en morfologisk analyse for å generere mulige kombinasjoner av faktor-variasjoner i de forskjellige scenario-temaene. De resulterende scenarioene lages i steg 6) og handlingsplanene i steg 7) og 8). Etter scenarioene ble laget ble en valideringsanalyse gjennomført for å forsikre at scenarioene fungerer som et tilstrekkelig grunnlag for beslutningstaking. Kriteriene scenarioene ble vurderes etter er 1) Plausibilitet, 2) Sammensetning, 3) Kreativitet og sammenheng og 4) Relevans. For å sjekke sammensetning gjennomføres en sammensetnings-analyse.

Hovedresultatene av denne oppgaven er fire scenarioer med navn Dry Well, Puddle, Ocean og Poseidon som alle beskriver mulige fremtidige situasjoner for industrien i 2050 og utviklingen som har ledet opp til denne.

Dry Well er det verste utfallet og beskriver en fremtid hvor industrien opplever en forverring i situasjonen til alle kraft-gruppene som påvirker industrien hvor miljøsituasjonen er hoved-driveren. Resultatet av denne forverrede situasjonen er at eksportvolumet fra den Norske havbruksindustrien har sunket til 150.000 tonn i 2050.

Puddle beskriver en fremtid hvor industrien ikke har klart å forbedre miljøsituasjonen og har derfor mistet den politiske viljen nødvendig for en opp-skalering av produksjonen. Resultatet av dette er at eksportvolumet fra den Norske havbruksindustrien har stagnert på 950.000 tonn i 2050.

River beskriver en fremtid hvor industrien har lykkes i å få til eksponert havbruk og ved å gjøre det har de eliminert lakselus-problemet på disse lokasjonene. De har derimot ikke lykkes i å forbedre miljøsituasjonen på de kystnære lokasjonene og dette har forårsaket en motvilje blant politikerne til å tillate en opp-skalering av produksjonen på disse lokasjonene. Resultatet av dette er at eksportvolumet fra den Norske havbruksindustiren er 2.110.000 tonn i 2050.

Poseidon er det best tenkelige utfallet og beskriver en fremtid hvor industrien har nådd alle sine 2050-mål. Dette er en ringvirkning av et valg industrien tok om å samarbeide for å løse miljøutfordringene

som viste seg å være vellykket. Dette kombinert med god markedsføring og en økning i global etterspørsel har resultert i at eksportvolumet fra den Norske havbruksindustrien har nådd 5.000.000 tonn i 2050.

For hvert scenario blir det laget en korresponderende handlingsplan. Hensikten med disse er å beskrive implikasjonene av scenarioene med tanke på avgjørelser og strategiske interesser, avgjøre om informasjonen om fremtiden validerer de originale antakelsene, avgjøre hva scenarioene antyder for designet og timingen av strategier, beskrive hvilke trusler og muligheter scenarioene foreslår, beskrive hvilke kritiske problemer som fremkommer i scenarioene, avgjøre hvilke saker som bør bli adressert av spesifikke beredskapsplaner, avgjøre hvilken type fleksibilitet og motstandsdyktighet som er nødvendig fra industriens planleggingsperspektiv og avgjøre hvilke faktorer som bør overvåkes. En fellesnevner i handlingsplanene er at å oppnå miljømessig bærekraft burde motta en høyere prioritet dersom industrien skal oppnå 2050-målene. En annen fellesnevner er at miljøproblemene hemmer industriens vekst i alle scenarioene hvor industrien ikke oppnår 2050-målene. Derfor foreslår alle handlingsplanene at miljøproblemene burde bli adressert av spesifikke beredskapsplaner.

Scenarioene og handlingsplanene oppfyller formålet med oppgaven siden alle beskriver mulige fremtidige utviklinger som kan oppmuntre beslutningstakerne som blir presentert for dem til å vurdere utviklinger de ellers ikke ville gjort. Videre, siden det er mange fordeler ved å implementere scenarioplanlegging som en del av et selskaps langsiktige strategi kan dette hjelpe selskaper å bedre gripe muligheter og unngå trusler i fremtiden, gitt at de er klar over fallgruvene ved å bruke scenarioplanlegging. Derfor, siden scenarioene og handlingsplanene kan oppmuntre beslutningstakerne presenter til dem til å se verdien av å implementere scenarioplanlegging oppfyller oppgaven målet om å fungere som et hjelpemiddel for å nå 2050-målene.

Konklusjonen i denne oppgaven er at scenarioene og handlingsplanene oppfyller hensikten, men for at aktørene i bransjen skal ha større nytteverdi av en scenarioplanleggings-analyse burde de implementere scenarioplanlegging som en del av deres egen langsiktige strategi.

Anbefalingene for videre arbeid som kan forbedre kvaliteten av analysen er å gjennomføre hele analysen i samarbeid med de involverte interessentene fremfor å bare bruke dem som inngangsinformasjon. For at individuelle selskaper skal ha større nytteverdi av denne oppgaven er anbefalingen å bruke denne oppgaven som en mal for hvordan gjennomføre en scenarioplanleggings-analyse og implementere scenarioplanlegging som en del av selskapets langsiktige strategi. Innen scenarioplanleggings-litteraturen er anbefalingen for videre arbeid å gjennomføre mer forskning på virkningen av scenarioplanlegging da det bare ble funnet ett studie i litteraturen som gjorde dette.

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1 Introduction

This chapter present the background, objective, scope and limitations and structure of the report.

1.1 Background

The only certainty about the future is that it is uncertain. Traditional forecasting methods typically work under the assumption that the future is dependent on what has happened in the past. This assumption may prove to be accurate for a short time horizon, but when the time horizon is expanded these methods often prove inaccurate. Further, traditional forecasting methods typically don't account for unforeseen events. When the time horizon is expanded, the probability of unforeseen events occurring increase as well. This is where scenario planning differs from traditional forecasting methods. Scenario planning is a method of preparing for the future where several plausible future scenarios are created. By doing this, the method can capture a wide range of possible future outcomes and thus stimulate decision makers to consider developments they would not otherwise. Imagining these developments may make the decision makers better prepared to handle uncertainty and unforeseen events (Finne, 2016, Shoemaker, 1995).

With an increasing world population, producing sufficient amounts of healthy food is a global challenge. It is estimated by the UN that within 2050 the world population will have reached 9,7 billion people and it is projected by the World Bank that by 2030, 62% of all consumed seafood will be farm raised. The increasing demand for food resulting from the world population growth poses a big opportunity for the Norwegian aquaculture industry to increase their export (UN, 2015, Bjelland et al., 2015, TheWorldBank, 2013).

Since its beginning in the 1970s, the Norwegian aquaculture industry has experienced a major growth in their production and in 2016, the value of exported products from the industry exceeded a value of 65 billion NOK. The industry has a goal that within 2050 the production volume of the industry shall reach a value of 5 million tonnes. This represent a 5-fold increase in production volumes. For the industry achieve this goal they must have a strategy of how to seize opportunities and avoid threats that may occur in the future. Since the time horizon for the goals of the industry is long, implementing scenario planning may prove to be a good strategy as an aid to achieve these goals (Furuset, 2017, Olafsen et al., 2012, NSC, 2017c).

1.2 Objective

The objective of this thesis is to create a set of scenarios of how the industry may develop towards 2050 and a set of corresponding action plans that considered may encourage decision makers to consider possible futures that they would not have otherwise and that may serve as an aid towards achieving the industry's 2050-goals.

1.3 Scope and limitations

To solve the objective of this thesis, a scenario planning analysis must be performed. To get a good basis to perform the analysis, the thesis will first present a description of the Norwegian aquaculture industry's current situation, its past development and its value chain. Next the 2050-goals of the industry and the prerequisites to achieve these goals will be presented. Further, to present a structured picture of the environment the industry operates in and a structured overview of the industry's strengths, weaknesses, opportunities and threats, a PESTEL-analysis, a competitive force analysis and a SWOT-analysis will be performed.

To perform the scenario planning analysis, it is necessary with input from stakeholders of the industry. A stakeholder map will therefore be created to identify the relevant stakeholders. From this map, a selection of stakeholders within different areas will be made for the interviews. To conduct the interviews a list of questions for the stakeholders will be made. When the interviews have been conducted and all the necessary input information has been collected, the scenario planning analysis will be performed. When the analysis has been conducted, the involved stakeholders will be presented with the results and encouraged to give feedback. Further, to ensure that the resulting scenarios serve as adequate basis for decision-making, the scenarios will be subject to a validation analysis.

A limitation to this thesis work is that this thesis only performs the scenario planning analysis using one approach whilst there exist several other approaches. Further, since the analysis in this thesis is only performed once, the resulting scenarios and action plans will not be revised over time as the input parameters change. Therefore, the results may become outdated as the situation of the industry change in the future.

1.4 Structure of the report

The thesis is divided into three main parts. Introduction to the topic of scenario planning, a scenario planning analysis, and a discussion and conclusion.

In the first part, Chapter 1 present the introduction to the thesis including its background, objective, scope and limitations. Chapter 2 present the methods used in this thesis. Chapter 3 is a literature review on the topic of scenario planning with a focus on what scenario planning is, its development, different methodologies, how to validate scenarios and their effectiveness and the advantages and disadvantages of using scenario planning. At the end of Chapter 3, a summary of the literature review is presented.

In the second part, Chapter 4 is divided into 2 sections. Section 4.1 present the Norwegian aquaculture industry's current situation, its past development, its value chain, its 2050-goals, the prerequisites to achieve these goals, a PESTEL-analysis, a competitive force analysis and a SWOT-analysis. In Section 4.2, the analytical part of the scenario planning analysis is performed. In Chapter 5 the resulting scenarios and action plans from the analysis performed in Chapter 4.2 is presented.

In the last part of the report, Chapter 6 is divided into 2 sections. Section 6.1 is a validation analysis to ensure that the scenarios created serve as adequate basis for decision-making. Section 6.2 is a discussion of the process, the results and the implications of the work performed. Chapter 7 present the conclusion of the work and Chapter 8 present recommendations for further work.

2 Method

The objective of this thesis is to create a set of scenarios and corresponding action plans for how the Norwegian aquaculture industry may develop towards 2050. This chapter describe and justify the different methods applied to achieve the objective.

2.1 Creating a basis for a scenario planning analysis

To gather the necessary data to form a basis for a scenario planning analysis of the Norwegian aquaculture industry, a literature review, a literature search and interviews with stakeholders within the industry have been performed.

The literature review has been conducted by comparing existing literature on the topic of scenario planning to form a basis for selecting the scenario planning approach as well as presenting an overview of what scenario planning is, how it has developed, the different methodologies, how to validate scenarios and the effectiveness of them and the advantages and disadvantages of using scenario planning. The literature search of the industry has been performed to gain an understanding of what the industry's current situation is, how it has developed, how its value chain is structured and where eventual bottlenecks exist, what their goal is for future development towards 2050 and what the prerequisites for achieving these goals are. The interviews have been performed to gain necessary information to perform the scenario planning analysis. The questions asked at the interviews are included in Appendix A.2 Interview questions. To gain an overview of the different stakeholders in the industry and to form a basis for deciding who to interview, a stakeholder map has been created. This is included in Appendix A.1 Stakeholder-map.

To get an organized view of the environment the industry is operating in, a PESTEL-analysis has been performed. A PESTEL-analysis is a systematic analysis of the business environment of a company or an industry. The PESTEL-analysis identify political, economic, societal, technological, environmental and legislative conditions that influence the industry as seen in Figure 1 below.

To get a structured overview of the competitive environment the industry operates in, a Porter´s five forces analysis has been performed. This is an analysis where the five competitive forces identified by Porter is evaluated. As can be seen in Figure 2 below, these are 1) Rivalry among existing competitors, 2) Threat of new entrants, 3) Bargaining power of buyers, 4) Threat of substitute products and 5) Bargaining power of suppliers. The advantage of this analysis is that it generates a structured view of how the different external competitive forces affect the industry and thus what opportunities and threats that the industry is facing. The disadvantage is that it does not account for innovation and only present a static image of the industry.

To organize the data gathered from the literature search and interviews and to get a structured overview of the industry, a SWOT analysis has been performed. A SWOT analysis is an analysis identifying a business or industry's strengths, weaknesses, opportunities and threat's. Figure 3 below illustrates the basic principle of the SWOT analysis.

Weaknesses of both the PESTEL-analysis and the SWOT-analysis is that it is difficult to cover all aspects that may affect an organisation or industry. However, by combining them, it is possible to get a more thorough view of the industry and the environment it operates in. The two methods are closely connected as the factors identified in the PESTEL-analysis serve as input for the opportunities and threats section in the SWOT-analysis.

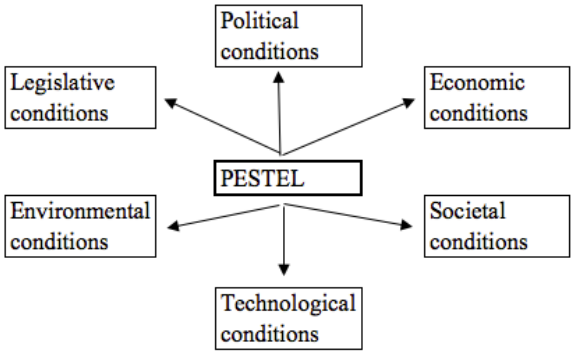


Figure 1: Illustration of a PESTEL-analysis

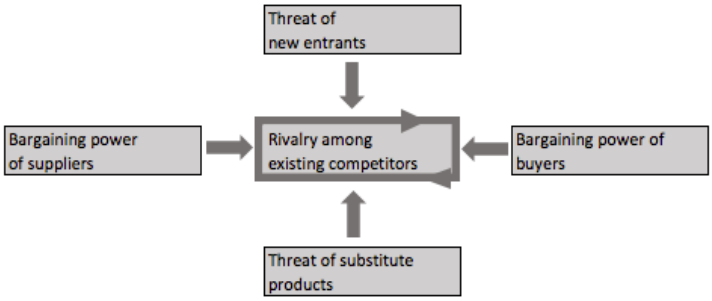


Figure 2: Illustration of a competitive forces analysis

Figure 3: Illustration of a SWOT analysis (Xhienne, 2007)

2.2 Scenario planning approach

The scenario planning approach used in this thesis is the SRI approach developed by Stanford Research Institute which is a qualitative approach that consist of eight steps as can be seen in Figure 4 below. The description of the method presented in this thesis is gathered from William R. Huss and Edward J. Honton's article "Scenario Planning – What style should you use?" (Huss and Honton, 1987).

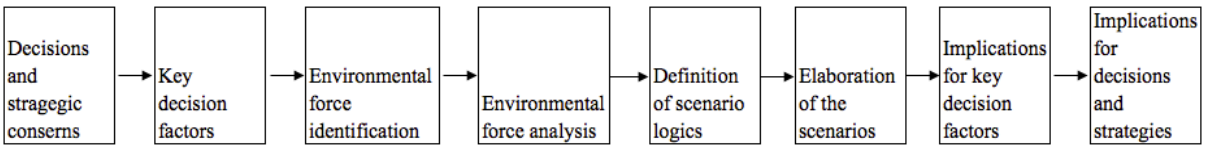


Figure 4: Steps of the SRI scenario planning approach

Step 1: Analysing the decisions and strategic concerns

The first step is to define the scope of doing the analysis. This is done by focusing on key decisions with long-range consequences and by identifying the goals of the industry during the planning horizon.

Step 2: Identifying key decision factors

The second step is to identify key decision factors. Examples of these factors are market size, capital availability, human resources, material resources, energy resources, environmental resources, economic conditions and price trends. Interviews with executives may add much insight to this process, however standard business analysis tools are usually sufficient. In this thesis, interviews with executives has been used.

Step 3: Identifying key environmental forces

The third step is to identify the environmental forces that may influence the industry. These forces shape the status of the key decision factors identified in step 2 and are typically economic, political, technological or social forces. They may include social and life style factors, demographic patterns, economic conditions, ecosystems, natural resources, political and regulatory forces, international conditions and technological forces.

Step 4: Analysing the environmental forces

The fourth step is to analyse the environmental forces. This analysis should include a discussion of critical uncertainties, trends, history and interrelationships among environmental forces. This analysis is intended to ensure that the driving forces for change in the scenarios are relevant to the purpose of the analysis and to ensure that the scenarios are plausible. In this thesis, each force is graded high, medium or low with respect to uncertainty and impact on the industry. Based on this evaluation, each force received a priority ranking using a Wilson matrix. The forces with high and medium priority act as the change-drivers in the scenarios.

A Wilson matrix is used to prioritize the environmental forces by placing them in different areas of a matrix based on their degree of uncertainty and impact on the industry as can be seen in Figure 5 below (Amer et al., 2012):

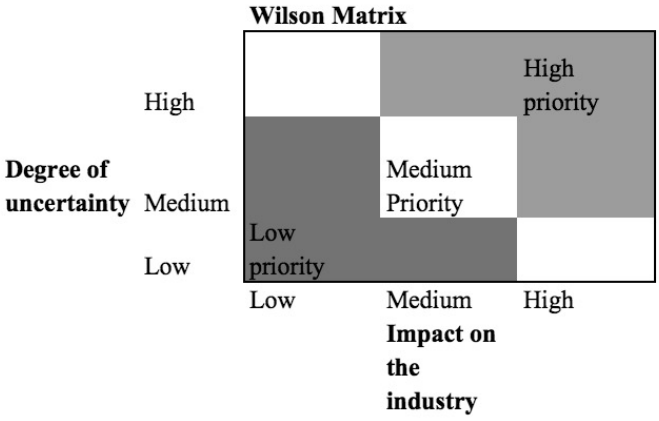


Figure 5: Illustration of a Wilson matrix

Step 5: Defining scenario logics

The fifth step is to define scenario logics which consist of organizing themes that describe alternative futures. Examples of scenario logics are seller's or buyer's market's and regulated or unregulated market's. These are not purely optimistic or pessimistic, but they represent both opportunities and threats for the industry. The scenario logics should incorporate all the elements from the previous steps and function as the themes for the scenarios to be created.

To create scenario logics and scenarios that contain the important chains of events, a cross-impact analysis is performed. A cross-impact analysis visualize the dependence different factors have on each other and identify the critical drivers. This is done by ranking the effect each factor has on the others. The effect each factor has on another is given a number from 0-3, where 0 implies that the factor is independent of the other, 1 dependent, 2 slight impact and 3 a strong driver. After each correlation between factors have been given a number, the summarized effect of each factor on the others are calculated. The factors with the highest score are the critical drivers. Figure 6 below illustrate an example of a cross-impact analysis. In the example, 5 factors F1-F5 respectively are identified. In the matrix, the effect of each factor on the others is given a rating from 0-3. From the score, it is evident that it is factor F1 and F2 which are the critical drivers in the scenarios(Amer et al., 2012).

When creating the scenario logics, a morphological analysis is used. This is an analysis used to generate plausible combinations by visually analysing different combinations of factor variations. In the example in Figure 7 below, 4 factors are identified, F1-F4 respectively. For each factor, there are 2 possible variations A and B. As seen in Figure 7, the implausible combinations of factor variations in this example are 1A-2B, 2A-3B, 2B-3A and 3B-4A and the lines illustrate the plausible combinations (Amer et al., 2012).

Cross Impact analysis

	F1	F2	F3	F4	F5	Score
F1		1	2	1	3	**7**
F2	0		3	2	2	**7**
F3	1	2		3	0	6
F4	3	1	0		2	6
F5	2	0	2	0		4

Highest score: F1 and F2

0 Independent	1 Dependent
2 Slight Impact	3 Strong driver

Figure 6: Illustration of a cross-Impact analysis

Morphological analysis

Factors / **Variations**	**F1**	**F2**	**F3**	**F4**
VA	1A: High	2A: Rise	3A: High	4A: High
VB	1B: Low	2B: Fall	3B: Low	4B: Low

1B-2A-3A-4A
1A-2A-3A-4B
1B-2B-3B-4B

Figure 7: Illustration of a morphological analysis

Step 6: Elaborating the scenarios

The sixth step is to elaborate the scenario logics and create full scenarios. To do this, the scenario logics are combined with the environmental force analysis and written as narratives describing the industry's situation in the future and the developments leading up to this future. The narratives should provide more focused information about the key decision factors and the environmental force analysis. In this thesis, a chart illustrating the future export volume from the Norwegian aquaculture industry in each scenario is created and attached to the scenarios. This will for all the scenarios be created on assumptions and is intended to serve as an illustration only.

Step 7: Analysing implications for key decision factors

The seventh step is to evaluate the implications of the scenarios created in step 6 with respect to the key decision factors identified in step 2.

Step 8: Analysing implications for decisions and strategies

In step eight, the following questions are addressed (Huss and Honton, 1987):

1) Does information about the future validate the original assumptions supporting strategies or proposed decisions?
2) What do the scenarios imply for the design and timing of strategies?
3) What threats and opportunities do the scenarios suggest?
4) What critical issues emerge from the scenarios?
5) What special cases deserve to be addressed by specific contingency plans?
6) What kinds of flexibility and resilience do the scenarios suggest are necessary from a company/industry's planning perspective?
7) What factors deserve monitoring considering the information gained from the scenarios?

Figure 8 below illustrate a flow chart of the different steps in the scenario planning analysis method. The output of the analysis is a set of scenarios and action plans. To create the scenarios, step 3-6 are used as the input and it is in step 6 that the actual scenarios are created. The action plans are created in step 7) and 8) using the scenarios created together with step 1), and 2) as input. After the scenario planning analysis has been performed the results should be revisited over time as the input parameters change.

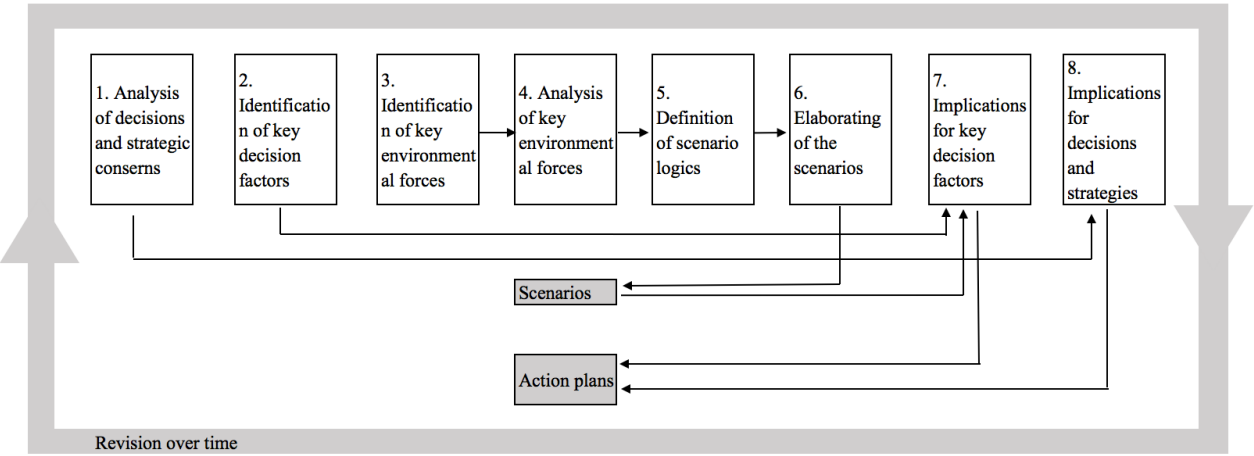


Figure 8: Flow chart of the steps in the scenario planning analysis method

The advantage of using the SRI approach is that it can develop flexible and internally consistent scenarios as it does not rely on mathematical algorithms. As it is a qualitative method it is also argued to be more useful when the planning horizon is long. Since the planning horizon in the analysis is long in this thesis, the SRI method has been chosen. The disadvantage of using the SRI approach is that it is highly dependent on the people involved in the process to achieve scenarios of high quality. This both applies in terms of the skills of the people performing the analysis and the quality of the input data used (Huss and Honton, 1987, Amer et al., 2012).

2.3 Result validation

To ensure that the scenarios created in the scenario planning analysis function as an adequate basis for decision-making, the scenarios will be subject to a validation analysis based on four criteria. These are 1) Plausibility meaning that all the scenarios are plausible to occur, 2) Consistency meaning that there is no inconsistency between the drivers in the scenarios, 3) Creativity and coherence meaning that the scenarios are presenting original perspectives and are coherent and 4) Relevance meaning that the scenarios are to aid decision-making by providing insight to the future relevant to the industry.

The validation analysis is performed by critically assessing the scenarios and by assessing feedback from the involved stakeholders with respect to the criteria. For criteria 2, a scenario consistency analysis is performed. An example of a consistency analysis is presented in Figure 9 below.

	C1	C2	C3	C4	C10	C11	C14	
C1								
C2	4							
C3	3	4						
C4	3	5	4					
C10	3	4	4	4				
C11	3	4	4	4	5			
C14	3	4	4	5	4	5		

1= Totally Inconsistent, 3= Neutral, 5= Supporting
2= Partially Inconsistent, 4= Slight Positive Impact,

Figure 9: Illustration of a scenario consistency analysis (Amer et al., 2012)

In the example in Figure 9 above, a scenario consists of 7 scenario drivers, C1, C2, C3, C4, C10, C11 and C14. Each combination of these scenario drivers is in the matrix given a rating between 1 and 5 where 1 imply that the drivers are totally inconsistent and 5 imply that the drivers are supportive of each other. In the example, there are no combinations of scenario drivers which are characterized as inconsistent. If the scenario in question was to contain inconsistent combinations of drivers, the scenario should be altered or discarded.

3 Literature review

This chapter present a review of previous literature relevant to the thesis work. The focus of the literature review is what scenario planning is, how it has developed, different types of methodologies, how to validate scenarios and the advantages and disadvantages of using scenario planning. In Section 3.6, a summary of the literature review is presented.

3.1 Definition of scenario planning

It is not possible to find one clear definition in the literature of what a scenario is and of what scenario planning is. In 1985 Michael Porter defined a scenario as "an internally consistent view of what the future might turn out to be – not a forecast, but one possible future outcome.". Peter Schwartz and Gill Ringland defined in their book "Scenario Planning, Managing for the Future" from 1998 scenario planning as "the part of strategic planning which relates to the tools and technologies for managing uncertainties of the future" (Porter, 1985, Schwartz and Ringland, 1998).

Muhammad Amer, Tugrul U. Daim and Antonie Jetter wrote an article reviewing the scenario planning literature in 2012. In this article, they present several different definitions about what scenarios are. These definitions are all somewhat similar and the common denominator is that a scenario is some form of story that describe a possible future that has been shaped because of decisions made. As cited by Amer et al., Herman Kahn who is considered father of scenario planning and one of the founders of future studies, a scenario is "a set of hypothetical events set in the future constructed to clarify a possible chain of events as well as their decision points" (Kahn and Wiener, 1967, Amer et al., 2012).

In 2001, Thomas J Chermack, Susan A Lynham and Wendy E. A. Ruona created a review of the scenario planning literature. In this review, they present a generalized definition of what scenario planning is and state that it is the telling of multiple stories that cover a variety of plausible future occurrences. As stated by Chermack et al. and Paul J.H. Shoemaker, what distinguishes scenario planning from traditional forecasting is that scenarios are not forecasts meaning that they do not attempt to predict one future. Rather they aim at challenging the thinking of the people involved and direct attention to aspects that would not have been considered otherwise (Chermack et al., 2001, Shoemaker, 1995).

Peter Bishop, Andy Hines and Terry Collins argue in an article from 2007 that scenario planning embodies two central principles in futures studies. These are 1) to think deeply and creatively about the future to avoid the risk of being unprepared and 2) prepare for multiple plausible futures as the future is uncertain. Bishop et al. state that scenarios are the stories of these multiple futures presented in formats that are analytically coherent and encourage imaginative thinking (Bishop et al., 2007).

A. D. Wright state in an article from 2000 that per Schwartz, scenarios are written as stories about different futures for two reasons. The first reason is that by presenting forecasts using graphs and numbers with little context it is difficult to gain useful understanding or meaning for the recipient of the information. The second reason is that since it is difficult to feel emotionally attached to graphs and numbers, scenarios written as stories have a higher psychologically impact and are thus easier to feel emotionally attached to. In the article, Wright present a definition of scenarios by Peter Schwartz that differ slightly from the definition in Schwartz's and Ringland's book from 1998. Wright states that Schwartz in his book "The Art of the Long View: Planning for the Future in an Uncertain World" state that "Scenario planning is about making choices today with an understanding of how they might turn out". Further, Wright argue that scenario planning differs from traditional forecasting in two areas. The first area is that scenario planning use the basis that the future cannot be predicted, but that dependent

on the sequence of events, some end-states are predetermined. The second area is that the planning process has a high focus in scenario planning and that the scenarios created should continuously be reviewed and edited as new knowledge becomes available (Wright, 2000, Schwartz, 1997).

Garry D. Peterson, Graeme S. Cumming and Stephen R. Carpenter argue in an article from 2003 that the aim of using scenario planning is to explore the future uncertainty surrounding the consequence of a decision by using contrasting scenarios. Per Peterson et al. "scenario planning is a systematic method for thinking creatively about possible complex and uncertain futures". They argue that instead of focusing on achieving high accuracy in the prediction of one single outcome, the central idea of scenario planning is to consider a variety of possible future scenarios. Peterson et al. argue that scenario planning differ from traditional forecasting methods as scenarios consider the effect of uncertainty of forces that the decision-makers cannot control. (Peterson et al., 2003).

Paul J.H Shoemaker argue in an article from 1995 that scenario planning differs from traditional planning methods in three ways. Firstly, scenarios create several futures exploring the joint impact of various uncertainties. In scenario planning these futures are viewed as equally probable of occurring. Secondly, Shoemaker argue that in scenario planning several of the variables are changed at the same time. This enable scenarios to capture the effect of major shocks or deviations in key variables. Thirdly, the scenario planning process is more than just the output of a forecasting analysis. Scenario planning attempt to interpret the outputs by identifying trends and clusters among the different outputs. In addition, scenario planning includes elements that is difficult to model such as introduction of new rules and regulations, thus scenario planning go beyond traditional planning methods (Shoemaker, 1995).

3.2 Development of scenario planning

Bradfield et al. state in their article "The origins and evolution of scenario techniques in long range business planning" from 2005 that the concept of scenarios has existed since the earliest recorded time and that the idea of scenarios can be traced back to the writings of the early philosophers. However, as a strategic planning tool Bradfield et al. state that the technique has its roots from military planning in form of war game simulations and that the first documented case of what may be defined as scenarios appear in the 19th century. Further, Bradfield et al. state that modern day scenario planning techniques emerged in the post-war period in the 1960s when a centre for the development of scenario planning techniques emerged in USA and France (Bradfield et al., 2005).

Further, Bradfield et al. state that the development of scenario planning techniques started with Herman Kahn at the Rand corporation in USA. Kahn who was the ranking authority on Civil Defence and strategic planning at the Rand corporation developed scenarios for the Air Defence System Missile Command. He developed scenarios of nuclear war by miscalculation and managed to demonstrate that military strategists did not base their future predictions on reasons but rather on wishful thinking. This had a major impact on the Pentagons thinking in the 1950s and 1960s. Literature on scenario planning was not widely published until Kahn in 1960 published the book "On Thermonuclear war" (Bradfield et al., 2005).

In 1961, Kahn left the Rand corporation and established the Hudson Institute and started applying his scenario methodology to social forecasting and public policy. In 1967 Kahn published together with Anthony J. Wiener the book "The Year 2000: A Framework for Speculation on the Next Thirty-Three Years". This book has been credited for providing one of the earliest definitions of scenarios to the literature and for demonstrating how scenarios may be a useful tool for policy planning and decision

making. In the literature, Kahn is often referred to as the "father" of scenario planning due to this book. After Kahn left the Rand corporation, two other members also left the Rand corporation and founded the Institute of the Future. The Institute of the Future along with the Stanford Research Institute (SRI) and the California Institute of Technology became pioneers within the field of future studies in USA because they experimented with scenario planning as a strategic tool (Bradfield et al., 2005).

Per Bradfield et al., the first documented use of scenario planning in business context was in 1972 when Pierre Wack at Royal Dutch Shell company adopted scenario planning as a permanent strategy inspired by the work of Stanford Research Institute. This is supported by Chermack et al. as they state in their review on scenario planning literature that per van der Heijden, Pierre Wack at the Royal Dutch Shell Company in 1967 suggested that planning 6 years ahead did not allow sufficient time to consider future forces in the oil industry. He therefore began planning for year 2000 and when the oil prices plummeted as the Yom Kippur war broke out Shell acted quickly as they were prepared for an oil price drop. Due to their early success with scenario planning, Shell has per Bradfield et al. become the most celebrated corporate advocate of scenario planning and their approach to scenario planning is often referred to as the "Shell approach" (Chermack et al., 2001, Heijden, 2000, Bradfield et al., 2005).

Per Chermack et al., Shells success with scenario planning, encouraged other organizations to incorporate scenario planning and by the late 1970s most Fortune 1000 corporations did so to. However, in the 1980s, scenario planning experienced a downturn in popularity because of the recession and corporate staffing reductions. Shell continued to have success with scenario planning in the oil industry in the 1980s and thus corporations began to re-integrate scenario planning. Scenario planning has since this in addition to business purposes in some cases been adopted at a national level successfully bringing diverse groups of people together. Per Bradfield et al., scenario planning as a strategic tool has since its beginning become more popular judging by the increased attention the topic has received in the literature (Bradfield et al., 2005, Chermack et al., 2001).

3.3 Scenario planning methodologies

Scenario planning has existed for over 40 years and during this period several techniques have been developed. There exist a lot of literature describing different approaches to scenario planning and the topic has been described as a methodological chaos (Bradfield et al., 2005).

In 1987, William R. Huss and Edward J. Honton wrote an article with the intention to compare some of the major approaches to scenario planning. In this article, it is argued that scenario planning can be divided into three categories. These are 1) the intuitive logics approach, 2) trend-impact analysis and 3) cross impact analysis (Huss and Honton, 1987).

The intuitive logics approaches to scenario planning assume that it is the relationship between economic, political, social, technological, environmental and resource factors that is the basis for business decisions. The approach does not rely on any mathematical algorithm but on the input from the participants. Therefore, the approach can develop highly flexible scenarios which can be adjusted to the needs of the user. However, this method is not suited in a modelling or scientific environment which require a more quantitative approach as it strongly rely on the reputation and communication skills of the people involved (Huss and Honton, 1987).

Trend-impact analysis creates scenarios using independent forecasts of the key dependent variables that are adjusted based on the occurrence of impacting events. Huss and Honton argue that since this

approach combines traditional forecasting techniques such as econometrics and time series with qualitative factors, it is useful for creating scenarios. The approach force the participants to identify the impacting forces and evaluate them in terms of importance and probability. However, the approach does not evaluate the impact the forces may have on each other and is intended to evaluate one single quantitative key decision or forecast variable where historical information exists (Huss and Honton, 1987).

The cross-impact analysis approach argues that the occurrence of key impacting events affect each other and therefore focus on the correlation between impacting events. Huss and Honton argue that the two most common methods of cross-impact analysis are the INTERAX approach developed by the Centre for Futures Research and the BASICS approach practiced by Battelle Columbus Division (Huss and Honton, 1987).

The INTERAX approach develop scenarios using a computerized model and depend on both analytical models and human analysists to shape alternative future environments. The way it does this is by developing scenarios one year at a time and allow participants to interact with the yearly scenarios. This enable them to experiment with policy options. It is argued by Huss and Honton that this method of scenario planning present a unique way of combining cross-impact analysis with trend-impact analysis. Further, the scenarios generated are easy to modify interactively and can be a tool for improving the skills of strategic analysists. The disadvantage of this approach is that the selection of events in the first interval is a random selection using Monte Carlo simulation based on user-entered probabilities. As a result, there is no evaluation of how likely combinations of events are to occur. In addition, the start-up costs are high and the process might prove difficult as many analysists are not experienced with interactive design processes (Huss and Honton, 1987).

The BASICS approach uses a computer program to run a cross-impact analysis of user-defined descriptors which is responsible for the scenario selection. From the scenario selection, sensitivity analyses are performed and forecasts are made. Then the implications of these forecasts are studied. Since the approach does not use Monte Carlo simulation, the results are a distribution of scenarios based on their likelihood of occurrence and their level of consistency. Further, since the approach uses both ranges of influencing variables and events, the user can consider a broader set of outcomes which provides additional flexibility. The disadvantage of the approach in comparison to INTERAX is that with BASICS the computer model generates end state scenarios. Therefore, the user does not have the ability to work through the developments that occur on a yearly basis as they can with INTERAX (Huss and Honton, 1987).

In 2012, Amer et al. argued like Huss and Honton that scenario planning can be divided into three main categories. However, their division is somewhat different. They argue that the three main categories are 1) Intuitive logics school, 2) Probabilistic modified trends (PMT) school and 3) French school – La prospective. They also argue that the intuitive logics approach generates scenarios on the belief that it is the relationship between different factors that are the basis for business decisions. The most frequently used technique within the intuitive logistics school is the SRI approach proposed by Stanford Research Institute. The probabilistic modified trends school consists of trend impact analysis and cross impact analysis. These methodologies generate scenarios by probabilistic modifying extrapolated trends. The French school – La prospective generate scenarios by creating normative future scenarios and idealistic future images. The aim of the scenarios in the French school is to serve as a guiding vision for policy makers and to be a basis for decisions (Amer et al., 2012).

Further, Amer et al. present the most frequently used quantitative scenario planning techniques. These are 1) Interactive cross impact analysis, 2) Interactive future simulations, 3) Trend impact analysis and 4) Fuzzy cognitive maps based scenarios. In the article, they argue that that combining quantitative and qualitative approaches to scenario planning is beneficial as they strengthen each other when they are combined. However, they argue that the qualitative approaches to scenario planning are more suited when the time horizon is long and vice versa as illustrated in Figure 10 below (Amer et al., 2012).

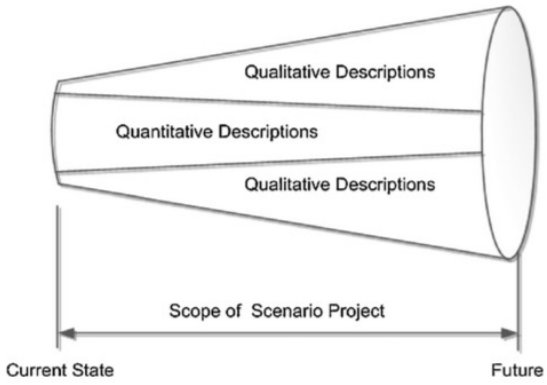


Figure 10: Quantitative versus qualitative scenario planning approaches (Amer et al., 2012)

Joseph P. Martino argue in an article from 2002 as mentioned by Amer et al. that scenarios remain qualitative in nature despite quantitative aids such as cross impact analysis (Martino, 2002).

3.4 Validation and effectiveness of scenarios

Chermack et al. claim in their article "A review of scenario planning literature" that for scenarios to be an adequate basis for decision-making, the scenarios must be checked for validity (Chermack et al., 2001, Amer et al., 2012).

In the literature, several scenario validation criteria are identified. Wilson present in his article "Mental maps of the future: an intuitive logics approach to scenarios" five criteria for selecting scenarios. These are 1) Plausibility meaning that the all the scenarios are possible, 2) Consistency meaning that there is no internal inconsistency and contradiction in the scenario logics, 3) Utility/relevance meaning that the scenarios should contribute with insight to the future that will aid decision-making, 4) Challenge/novelty meaning that the scenarios should challenge conventional wisdom about the future and 5) Differentiation meaning that the scenarios should not be variations of the same theme, but structurally different (Amer et al., 2012, Wilson, 1998).

Like Wilson, van der Heijden identify five basis criteria scenarios must fulfil. These are: 1) To reflect uncertainty it is necessary to create at least two scenarios, 2) All the scenarios must be plausible, 3) The scenarios must be internally consistent, 4) All the scenarios must be relevant to the clients concern and 5) The scenarios must present a new or original perspective (Heijden, 1996, Amer et al., 2012).

Amer et al. identified in their article "A review of scenario planning" seven different criteria for scenario validation that has been identified in the literature by researchers and futurists. These are 1) Plausibility, 2) Consistency/coherence, 3) Creativity/novelty, 4) Relevance/pertinence, 5) Importance, 6) Transparency and 7) Completeness/correctness. As seen in Table 1 below, the criteria that is most agreed upon to use for scenario validation is plausibility, consistency, creativity and relevance (Amer et al., 2012).

In Table 1 below it is evident that consistency is the criteria that is identified by the most researchers and futurists in the literature. To verify the internal consistency of the scenarios it is possible to conduct a scenario consistency analysis which is explained by Amer et al. in their article "A review of scenario planning". Figure 11 below illustrate how a scenario consistency analysis look like (Amer et al., 2012).

Table 1: Summary of scenario validation criteria (Amer et al., 2012)

Summary of scenario validation criteria.

Source	Scenario validation criteria						
	Plausibility	Consistency/ coherence	Creativity/ novelty	Relevance/ pertinence	Importance	Transparency	Completeness/ correctness
Alcamo and Henrichs [133]	X	X	X	X			
Van der Heijden [9]	X	X	X	X			
Durance and Godet [8]		X	X	X	X	X	
Bradfield et al. [13]	X	X		X			
Porter et al. [31]	X	X					X
Intuitive logics methodology [13]	X	X	X	X			X
La prospective methodology [13]	X	X					X
Burt [76]	X	X					
de Brabandere and Iny [19]	X	X	X	X		X	
Paul Schoemaker [15,51]	X	X					
Peter Schwartz [10,50]	X	X					X
Peterson et al. [135]	X	X					
Wilson [114]	X	X	X	X			
Vanston et al. [118]	X	X		X			
Kosow and Gaßner [136]	X	X				X	X

	C1	C2	C3	C4	C10	C11	C14	
C1								
C2	4							
C3	3	4						
C4	3	5	4					
C10	3	4	4	4				
C11	3	4	4	4	5			
C14	3	4	4	5	4	5		

1= Totally Inconsistent, 3= Neutral, 5= Supporting
2= Partially Inconsistent, 4= Slight Positive Impact,

Figure 11: Consistency matrix for a raw scenario (Amer et al., 2012)

Amer et al. state that the consistency analysis is aimed at checking the compatibility of combined compositions of drivers in the scenarios as well as reducing the number of scenarios into a manageable number. In their article, Amer et al. state that Pillkahn suggest assigning each combination of scenario drivers in the scenarios a score of 1-5 where a score of 1 imply total inconsistency and a score of 5 imply that both drivers are highly consistent (Amer et al., 2012, Pillkahn, 2008).

Peterson et al. argue in their article "Scenario Planning: A Tool for Conservation in an Uncertain World" that to test scenarios for consistency a strong test is to involve various actors and stakeholders in the scenario process. The intention of doing this is to ensure that the behaviour of the actors involved in the scenarios is plausible. Further, Peterson et al. argue that scenarios need to be tested and refined through several iterations before they can be used for policy evaluation (Peterson et al., 2003).

In the literature, studies aimed at identifying the effectiveness of scenarios are practically absent. Chermack et al. describe in their article "A review of scenario planning literature" a study of the

effectiveness of scenarios performed by Shoemaker in 1995. In this study, Shoemaker asked 68 MBA students at the University of Chicago to identify critical issues in their daytime jobs and provide a best guess and confidence ranges for those issues. Then, the students developed scenarios for the development of these issues and were asked to provide a new best guess and a new set of confidence ranges. After creating the scenarios, the confidence ranges were found to widen on average by 50% and the effect of implementing scenarios were significant on the best guesses. The study did not directly evaluate the effect of implementing a scenario project, however, it did prove that in the scenario planning process, considering options will have an impact on perceptions of outcomes (Chermack et al., 2001, Shoemaker, 1995).

3.5 Advantages and disadvantages of using scenario planning

This section of the literature review present the advantages and disadvantages of using scenario planning identified by researchers and futurists in the literature.

Advantages

Shoemaker argues that scenario planning attempts to capture a wide range of possible future outcomes, thus stimulating decision makers to consider developments they would not otherwise. Further, scenario planning create narratives of possible future outcomes that are easier to grasp and use due to their format (Shoemaker, 1995).

According to Peterson et al., scenario planning may aid to avoid potential traps and benefit from potential opportunities in the future as scenario planning aims to enhance the participant's ability to effectively respond to a wide range of possible futures (Peterson et al., 2003).

Chermack et al. state in their review of scenario planning literature that scenario planning open the eyes of the participants to consider a vast future landscape. Since scenario planning focus on creating long- and short-term stories of how the future may unfold, scenario planning challenge the participants current thinking as they are forced to consider paradigms they wold not otherwise. Chermack et al. further state that even though scenario planning was created as a tool for decision-making, the scenario planning process function as a tool for organizational learning as it maps mental models, challenge these and improve them (Chermack et al., 2001, Georgantzas and Acar, 1995).

In the article "A review of scenario planning", Amer et al. identify several advantages of using scenario planning. Among these are that scenario planning may enable the realisation of a desired future outcome as the scenarios identify future implications and the consequences of choices or policy decisions. Further, Amer et al. state that scenario planning help organizations test their strategies and that by considering several possible futures, the organizations ability to cope with uncertainty is enhanced. (Amer et al., 2012, Saliba, 2009, Strauss and Radnor, 2004, Heijden, 1996).

Elina Hiltunen argue in an article named "Scenarios: Process and Outcome" that scenarios enable organizations to better prepare for the future for two reasons. The first reason Hiltunen identified is that scenarios help prepare for alternative futures and question persistent beliefs about the future. The second reason is that the scenario planning process innovate the future as it breaks the existing mental models about the future and thus encourage to create something new. Further, Hiltunen argue that the use of scenario planning help organizations test their strategies as the scenarios enable the organizations to test their current strategies for various future environments (Hiltunen, 2009).

Disadvantages

Peterson et al. state that scenario planning as other forecasting methods risk falling into traps. Common traps are overestimating one's ability to control the future and overweighting the present. Further, since scenario planning often deal with issues outside the expertise of most people, relying on expert opinions or local knowledge can reduce the quality of the scenarios. Further, Peterson et al. state that the biggest trap of using scenario planning is the possibility of being wrong and the inability of the participants to perceive their own assumptions. According to Peterson et al. there is no easy way to avoid falling into these traps, but being aware of them and by being reflective during the process can help guard against them (Peterson et al., 2003).

According to Wright, Paul J.H Shoemaker has identified 20 pitfalls of using scenario planning. The ones highlighted by Wright are perennial call for top-management support, failure to stimulate new strategic options, not seeing the scenario planning process as an integrated process with other organizational decision making processes, balancing immediate concerns of management on short-term results with long-term focus areas and confronting managers with scenarios in such a way that they get defensive and reject them. Wright further highlights that scenarios need to be able to balance what the future might bring with what the organizations are ready to contemplate (Wright, 2000, Fahey, 1998).

Graham T.T Molitor argue in his article "Scenarios: Worth the effort?" that the use of scenarios at best reinforce what the participants already know and that scenario planning rarely discover any new insight. In this article, Molitor describe the scenario planning process to be a time-consuming "parlor game". Molitor further argue that the quality of the scenarios is dependent on the input and thus, if the participants are not "up to speed" on the topics discussed as input to the scenarios, the results are likely to be of poor quality (Molitor, 2009).

3.6 Summary of the literature review

There exist no clear definition of what scenarios or scenario planning is in the literature and many researchers and futurists have presented their own definitions. Herman Kahn who is considered father of scenario planning defined a scenario as "a set of hypothetical events set in the future constructed to clarify a possible chain of events as well as their decision points". Peter Schwartz state that "Scenario planning is about making choices today with an understanding of how they might turn out" (Wright, 2000, Schwartz, 1997, Kahn and Wiener, 1967, Amer et al., 2012).

The development of scenario planning started for business purposes in the 1960s and had its breakthrough when Royal Dutch Shell incorporated scenario planning as a part of their strategy and created scenarios where the oil prices dropped. Having prepared for an oil price drop, when the Yom Kippur war broke out Royal Dutch Shell handled the fall in oil prices much better than their competitors. Their success with scenario planning became an inspiration for many other companies (Bradfield et al., 2005).

There exist a lot of literature describing different approaches to scenario planning and the topic has been described as a methodological chaos. It is possible to divide the different approaches into two main groups, quantitative approaches and qualitative approaches. It is argued in the literature that quantitative approaches are best suited for short planning horizons while qualitative approaches are best suited for long planning horizons (Amer et al., 2012).

There is an agreement in the literature that for scenarios to serve as an adequate basis for decision-making, the scenarios must be checked for validity. The four validity criteria identified by most researchers and futurists are 1) plausibility, 2) consistency/coherence, 3) creativity/novelty and 4) relevance/pertinence. Of these four, consistency is most frequently ranked as important (Amer et al., 2012, Chermack et al., 2001).

Studies aimed at evaluating the effectiveness of scenario planning is practically absent from the literature. One study of the effect of implementing scenario planning was conducted by Shoemaker in 1995. The study did not directly evaluate the effect of implementing a scenario project, however, it did prove that the scenario planning process has an impact on the perception of outcomes (Chermack et al., 2001, Shoemaker, 1995).

In the literature, several advantages and disadvantages of using scenario planning are identified. The advantages most frequently mentioned in the literature is the ability to stimulate decision-makers to consider developments they would not have otherwise, aid decision-makers to avoid threats and seize opportunities in the future, aid organizations to test their strategies and enable organizational learning (Shoemaker, 1995, Chermack et al., 2001, Georgantzas and Acar, 1995, Heijden, 1996).

Paul Shoemaker identified 20 pitfalls of using scenario planning according to Wright. The ones highlighted by Wright are perennial call for top-management support, failure to stimulate new strategic options, not seeing the scenario planning process as an integrated process with other organizational decision making processes, balancing immediate concerns of management on short-term results with long-term focus areas and confronting managers with scenarios in such a way that they get defensive and reject them. Wright further highlight that scenarios need to be able to balance what the future might bring with what the organizations are ready to contemplate (Wright, 2000, Fahey, 1998).

4 Study of the Norwegian aquaculture industry

This chapter present the individual studies. In Section 4.1, a study of the Norwegian aquaculture industry is performed and in Section 4.2, a scenario planning analysis of the industry is performed.

4.1 The Norwegian aquaculture industry

This section present the Norwegian aquaculture industry's current situation, its past development, its value chain, its 2050-goals, the prerequisites to achieve the 2050-goals, a PESTEL-analysis, a competitive force analysis and a SWOT-analysis of the industry.

4.1.1 Current situation

The Norwegian aquaculture industry has since its beginning experienced a rapid growth in both production volume and export value. Figure 12 below illustrate the export value of products from the Norwegian aquaculture industry and the Norwegian fisheries from 1991 to 2016. In Figure 12 it is visible that the aquaculture industry has experienced a major growth in export levels in comparison to the fisheries and in 2016, the export value of Norwegian seafood set a record at 91,6 billion NOK. The Norwegian aquaculture industry is responsible for 71,5% of this increased export and since 2008 the industry has tripled their export levels. Of the cultivated fish, salmon accounted for approximately 94% of the production volume and value creation in 2015. Compared to other industries in Norway, the aquaculture industry is a major contributor to the BNP as can be seen in Figure 13 below (NSC, 2017b, NSC, 2017c, Baklien and Steinset, 2016).

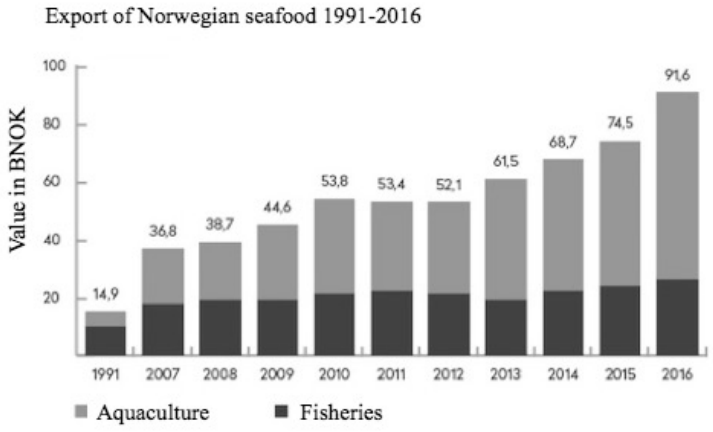


Figure 12: Export of Norwegian seafood 1991-2016 (NSC, 2017b)

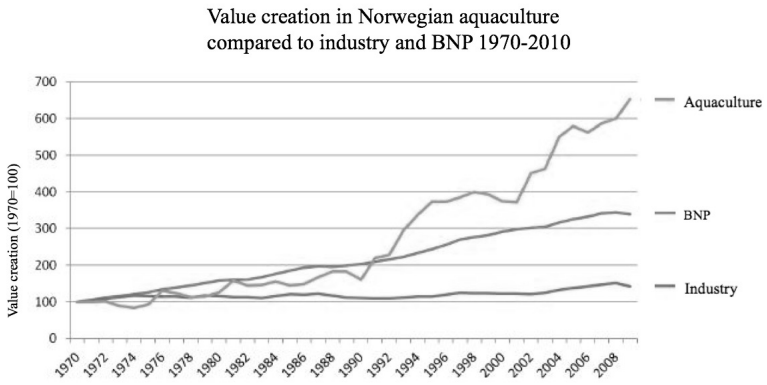


Figure 13: Value creation from aquaculture compared to other industries (NF, 2014)

Figure 14 below present the global production of Atlantic salmon from 2005-2014. In the chart, the top line is the total production and the line below is the Norwegian production. By studying the chart, it is visible that the Norwegian aquaculture industry has experienced a steady growth in production volume compared to the other nations and in 2014, the Norwegian production of Atlantic salmon accounted for approximately 53% of the global production.

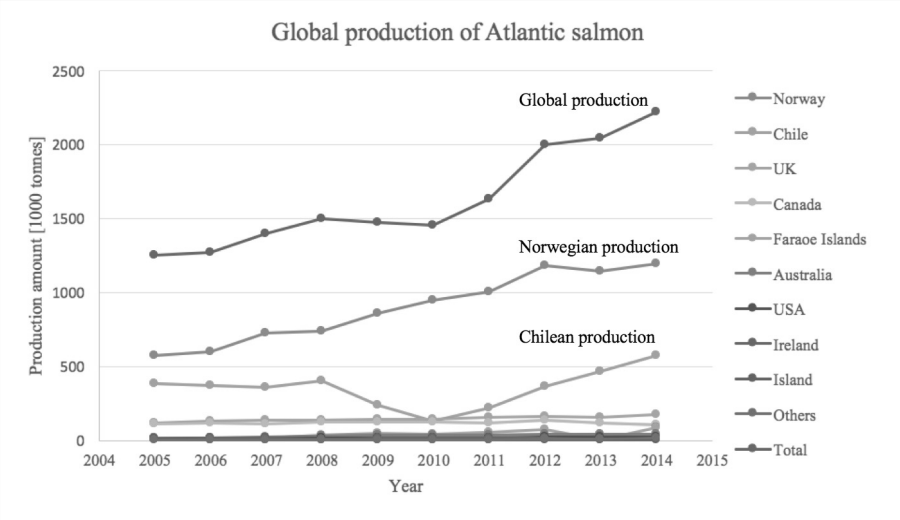


Figure 14: Global production of Atlantic salmon 2004-2015 (Regjeringen, 2015)

Today the main export markets for the Norwegian aquaculture industry are Poland, France, Denmark, Great Britain, USA, Japan, the Netherlands, Sweden, Spain and Italy. For future expansion of the industry, the markets considered to be of high potential in the coming decade are Brazil, Russia, India, China and South Africa. These countries are of high potential as they are expected to grow both in terms of population size and in purchasing power in the middle class (NSC, 2017a, NSF, 2012).

In addition to providing Norway with high export-incomes, the Norwegian aquaculture industry is one of the major employers in Norway and it is estimated that in 2014 approximately 5700 people were directly employed in the industry and 20.000 indirectly (NF, 2015).

4.1.2 Past development

The development of the Norwegian aquaculture industry first started in the late 1950s when Theis Jakobsen started importing live rainbow-trout from Denmark and fed them in fresh water. At the same time Erling Osland quit his job and made aquaculture his main source of income. This inspired Karsten and Olav Vik who in 1961 started cultivating rainbow trout in floating wooden crates in the sea and noticed that the rainbow trout gradually adjusted to the seawater. In 1968, Professor Harald Skjervold at the Norwegian Agricultural College got permission to collect broodstock salmon and roe from Norway, Sweden and Denmark. With this permission, he established the aquaculture program for Norwegian salmon (NSC and SN, 2016).

In 1970, Ove Grøntvedt and Sigvert Grøntvedt created what is considered the world's first fish pen for salmon production and released 20.000 salmon smolt. This proved to be profitable and they made profits in their first year of production. In 1972, an academic committee was impaired by the government to explore the potential of aquaculture and to decide the need for knowledge, the form of organization and the regulation of the industry. Their conclusion was that each facility must be of such a size that it functions as an independent source of income. In 1973, the parliament adopted a law of concession

aiming at regulating the development of the industry to strengthen the Norwegian coastal society and enable the government to make demands regarding the quality of the facilities (NSC and SN, 2016).

After a rapid upscaling in 1974, the industry experienced a major downturn as the competing parties started to undersell each other. To solve this, the industry together agreed to start freezing their products rather than to sell them cheap. In the period from 1972-1975, the industry grew by 40% each year and for the first time in 1977, the production of salmon was bigger than the production of rainbow trout. The rapid growth of the industry continued and in 1978 a stop of concessions was introduced. By 1980, the industry had increased its production from 500 tonnes in 1970 to 8.000 tonnes. In the 1980s the northern counties were prioritized when giving concessions to ensure that the whole coastline could participate in the industry (NSC and SN, 2016).

In 1981, the regulation of the industry was relocated from the department of agriculture to the department of fisheries and a new aquaculture law was introduced. In 1983, sickness in the mares became a major issue. Attempting to solve this a project named "Healthy Fish" was initiated. However, in 1984 infectious salmon anemia erupted in the fish pens (NSC and SN, 2016).

In 1985, a new law of cultivating fish and shellfish was introduced which only required a registration of hatchery and not a concession. The result of this was overinvestments within the industry. In 1986, Thor Listaus initiated a project intended to double the export of Norwegian salmon to japan named "Project Japan". This project proved very successful as the Norwegian salmon managed to enter the Japanese sushi market and the export increased by 250%. Due to the high growth in production volumes, the salmon prices halved in the period from 1985-1989 and by 1990, the production had reached a value of 170.000 tonnes compared to 8.000 tonnes in 1980. To regulate the market, a settlement to start freezing products was introduced. In 1991, Norway was accused by USA for dumping of salmon prices. Thus, USA introduced penalty duties on import of Norwegian salmon at 26% and from 1990-1991 the export to USA fell by 91% to a level of 800 tonnes (NSC and SN, 2016).

By 1995, there were 1220 facilities for salmon and trout production and by 2000 the export of Norwegian salmon reached 343 000 tonnes. In 2005, a new law was introduced by the parliament to promote the aquaculture industry's profitability and competitiveness with a focus on a sustainable development, and to contribute to value creation along the coastline. By 2006, the products from the Norwegian aquaculture became responsible for 50% of Norway's export of seafood (NSC and SN, 2016).

By 2008, the demand for sushi both nationally and internationally grew by approximately 30% per year and thus the demand for Norwegian salmon continued to grow. For the industry to continue to grow in an environmentally sustainable way, the Fishery- and Coastal Department launched their strategy to ensure an environmentally sustainable aquaculture industry. In 2010, the use of CO2 as tranquilizer was phased out and replaced by hits and punches (NSC and SN, 2016).

In 2011, the industry's biggest challenges were escapes and salmon-lice. Therefore, the companies who were organized in the Fishery- and aquaculture union committed to new measures aiming at preventing cultivated salmon to affect the wild salmon stock. In 2012, Norwegian seafood companies participated in the development of a non-profit organization named Aquaculture Stewardship Council (ASC) which was founded in 2010. The Aquaculture Stewardship Council was founded to manage global standards of how to run aquaculture production responsibly. In 2013, the government introduced "green" concessions to stimulate technology development within the industry. These "green" concessions

implied that a part of the earnings the government had from the aquaculture industry should go to the counties with aquaculture industry rather than to the government (NSC and SN, 2016).

In 2014, the export of Norwegian seafood reached a new high with a value of 61 billion NOK and the first salmon from Norwegian aquaculture was certified by the Aquaculture Stewardship Council (ASC). In 2015, the Norwegian aquaculture industry became the world's biggest producer of Atlantic salmon with a global market share of 53%. Further, in 2015 the government released development concessions to stimulate development of new technology including solutions to achieve exposed aquaculture (NSC and SN, 2016).

At the end of 2015 another record was set by the industry when the export value of Norwegian salmon and trout exceeded 50 billion NOK, and by the end of 2016, the combined export value of Norwegian seafood exceeded a value of 91 billion NOK (NSC and SN, 2016, Furuset, 2017).

4.1.3 Value chain

The value chain of the Norwegian aquaculture industry can be divided into six groups of activities as illustrated in Figure 15 below. The first group is breeding and hatchery. This is the part of the value chain where the smolt used for salmon production is produced. The next activity is fish farming conducted by the seafood companies. Next, when the salmon is finished it is processed which include slaughtering and freezing. The last part of the value chain is export and trade of the finished products.

In parallel to these activities, a range of suppliers are involved in the process of delivering various equipment and services. These include pharmaceutical companies, equipment providers, service companies and fish feed companies. Logistics and transportation is also an essential part of the value chain of the Norwegian aquaculture industry. Logistics and transportation is involved in all the major steps and the actors involved include ship operators and trucking companies.

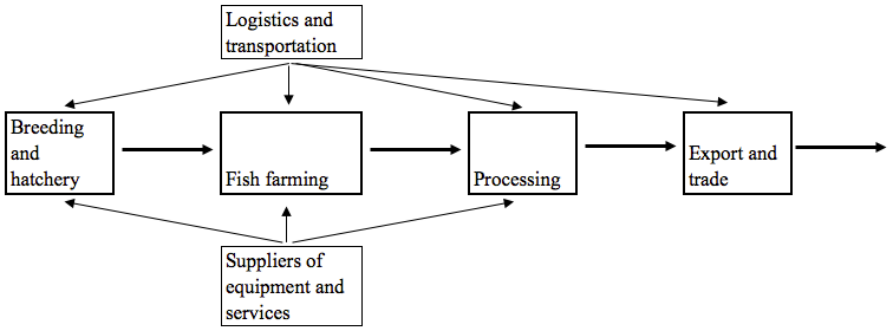


Figure 15: Value chain of the Norwegian aquaculture industry

Figure 16 below illustrate the different steps in the production of Norwegian salmon and the time necessary for each step. As seen in Figure 16, the production start with fertilization of roe. For the roe to hatch and become fry which is the earliest life stage of the salmon it takes approximately 60 days. For the fry to be able to get its nutrition from fish feed it takes 4-6 weeks and when it has undergone this process it is moved from the hatching tank to a bigger tank. In this tank, the fry start the process of being able to survive in seawater. This process takes between 10 to 16 months and when the fry has undergone this process it is called smolt (Finne, 2016, SN, 2011).

When the fry has developed into smolt, it is transported to fish farms in the ocean. The smolt is kept in the fish farms until it reaches its target weight of 4 to 6 kilos which takes between 14 and 22 months. During the growth period in the fish farms, the fish undergo various inspections and delousing treatments. When the smolt has undergone this process, and developed into finished salmon, the salmon is transported to slaughtering and processing in well-boats. When the salmon has been processed, it is transported to wholesalers who then sell nationally or export the finished products (Finne, 2016, SN, 2011).

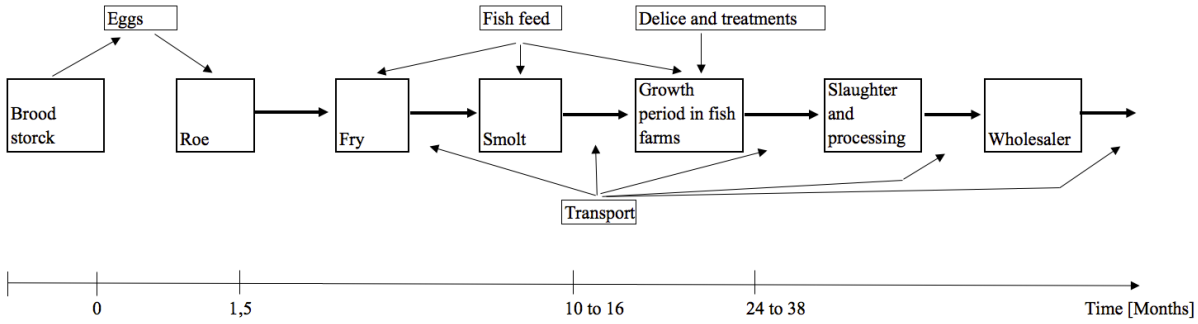


Figure 16: Value chain of salmon production

Bottlenecks and implications

It is evident that the value chain of the Norwegian aquaculture industry is characterized by a long lead time. From the production is initiated, it takes 2-3 years until the product is finished and ready to be sold. This imply that if changes to the value chain are made today, it will take 3 years for the effect of these changes to reach the market. This long lead time is not possible to reduce as there is no way of fast-tracking the processes the salmon must undergo to become a finished product. It can be argued that the bottleneck in the value chain for salmon production is the growth period in fish farms as this is the activity that has the longest duration of 14-22 months.

Since the lead time of the industry is long it can be argued that the value chain has a low responsiveness. However, since salmon can be characterized as functional product with predictable demand and a long product life cycle, an efficient supply chain achieve a better strategic fit than a responsive value chain (Chopra and Meindl, 2016).

4.1.4 The 2050-goals

The Norwegian aquaculture industry's main goal is that within 2050, the production levels shall have reached a level of 5 million tonnes which is equivalent to approximately 240 BNOK in export value with today's salmon prices. This represent a 5-fold increase in production levels in 2050 compared to 2010.

Further, a goal for the industry is to solve the environmental challenges pointed out in the government's strategy for sustainability. To do this, the industry must solve the issues related to genetic influence on the wild stocks and escapes, illness including parasites, pollution and emissions, feed resources and available area for production. In addition, the industry is to continue to be one of the major employers in the Norwegian society (Finne, 2016, Olafsen et al., 2012).

4.1.5 Prerequisites to achieve the 2050-goals

For the Norwegian aquaculture industry to be able to reach the 2050-goals presented in Section 4.1.4, there exist some prerequisites. The first prerequisite for growth is that the industry develops

constructions for aquaculture that can endure the increase in strain the environmental forces may impose in the future because of climate changes. The next prerequisite is that the industry ensures a good fish health for the cultivated fish as this can be regarded as a competitive advantage and may be a necessity to penetrate new markets. Further, ensuring good fish health is a necessity to ensure long term growth of the industry because a growth where fish health is not a priority may cause severe economic consequences for the industry as well as undesired environmental consequences. The industry must also address the high mortality of salmon in the production. A high mortality in the production has severe economic consequences and may be an indicator that the health of the fish in the production is poor. In addition, a high mortality among the cultivated fish is not efficient with respect to use of area and input-factors (Regjeringen, 2015).

Further, the industry must comply with rules and regulations regarding environmental concerns. As with all other forms of food production, aquaculture has an environmental footprint. In comparison to land-based food production, the footprint of the Norwegian aquaculture industry is small in terms of resource usage, area usage and emission. Today, the greatest environmental challenges for the industry is the escape of cultivated salmon and the spread of salmon-lice from the cultivated stock onto the wild salmon stock. If the industry is going to reach the goal of upscaling their production, the upscaling must be done in an environmentally sustainable way where these challenges does not result in the government introducing stricter rules and regulations inhibiting the growth of the industry. Environmental sustainability is the prerequisite with the highest priority when the government impose new rules to regulate the growth of the industry (Regjeringen, 2015).

The next prerequisite to achieve the 2050-goals is that the industry ensures sufficient area for an upscaling of the production. One of the competitive advantages of the Norwegian aquaculture industry is its access to area along the coast of Norway. However, if the industry is going to upscale their production, gaining sufficient production area is a challenge. Prioritizing technology development may enable the industry to gain this area as new aquaculture technology may enable the industry to use areas that previously were not suited for production (Regjeringen, 2015).

Another prerequisite is the market situation. The industry has met trade barriers in the past and it is not unlikely that it will do so in the future as well. Further, the possibility that countries that today don't produce salmon will start production and penetrate markets cannot be excluded. The possibility of substitute products is also present. This may lead to a decrease in the demand for salmon and thus lower export incomes for the Norwegian aquaculture industry. However, with the world population boom combined with increasing buying power in the middle class, the market situation for Norwegian salmon is currently promising. In addition, the Norwegian salmon is widely recognized to be a healthy product of good quality around the world. Therefore, maintaining this reputation is a prerequisite to reach the 2050-goals (Regjeringen, 2015, Finne, 2016).

4.1.6 PESTEL-analysis

This section present a PESTEL-analysis of the Norwegian aquaculture industry identifying political, economic, social, technological, environmental and legal conditions that influence the industry. The aim of this analysis is to present a structured picture of the external environment the industry operates in.

Political conditions

The Norwegian aquaculture industry is heavily dependent on the political condition both nationally and internationally. Nationally, the government is the one regulating the production of the aquaculture

companies and the one that give licences to operate. The industry is therefore dependent on that the government does not inhibit the production of the industry and the presence of political will to facilitate further growth. Internationally, the industry is dependent on not meeting political resistance for its products in the markets they already operate in and in the markets the industry intends to penetrate. The industry is also dependent on political stability in their export markets as political instability may cause trade barriers to be introduced.

Economic conditions

The Norwegian aquaculture industry's profit is dependent on the relationship between production price and sales price of their products. The industry's profit is also dependent on the currency rate of the Norwegian krone. For further expansion of the industry, it is dependent on increased buying power in the middle class as this is a prerequisite for an increase in demand for Norwegian salmon.

Social conditions

To expand the industry's production levels to such an extent that is defined in the 2050-goals, the industry is dependent on a continuing growth of the world population. This increase in population combined with increased buying power in the middle class represent a likely increase in demand for Norwegian seafood. Further, the products of the Norwegian aquaculture industry are regarded worldwide as a healthy, high quality product. The industry is therefore dependent on not losing this reputation. Health trends may also impact the Norwegian aquaculture industry. Therefore, the industry is dependent on salmon remaining its status as a healthy product.

Technological conditions

The Norwegian aquaculture industry is characterized by a high degree of technological innovations. An advantage for the Norwegian aquaculture industry is that Norway possess a good resource pool for technology development and many individuals with great knowledge due to its offshore-industry. For the industry to be able to increase their production sufficient to reach the 2050-goals, more technological innovations and the attraction of talented personnel is necessary. New technological innovations are also necessary to handle the climate changes that are expected to occur in the future.

Environmental conditions

Norway's oceanic and coastal environment is one of the advantages of the Norwegian aquaculture industry. The environmental footprint of the Norwegian aquaculture industry is relatively small in comparison to land based food production. However, due to the way the production is conducted today, the industry influence their surrounding environment. The biggest challenges are escape of cultivated salmon and the spread of salmon-lice onto the wild salmon stock. Other areas where the industry influence their surrounding environment are pollution and emissions, diseases, other parasites than salmon-lice and in the use of feed resources (Regjeringen, 2015).

Legal conditions

The Norwegian aquaculture industry is strictly regulated by the government. The focus of the government when introducing rules and regulations is to ensure that the development of the industry is sustainable in terms of environmental, social and economic sustainability. Of these, environmental sustainability receives the highest priority. To operate, the actors within the industry need permits issued by the government (Regjeringen, 2015).

4.1.7 Competitive force analysis

This section present a competitive force analysis of the Norwegian aquaculture industry. As this thesis focus on the entire Norwegian aquaculture industry and not one single company within the industry, the industry will in this analysis be regarded as one entity. The aim of this analysis is to present a structured picture of the competitive environment the industry operates in. Table 2 below present a summary of the competitive force analysis.

Table 2: Summary of competitive force analysis

Force	Impact on the industry
Rivalry among existing competitors	Low
Threat of new entrants	Low
Barganing power of buyers	Medium
Threat of substitute products	Medium
Barganing power of suppliers	High

Rivalry among existing competitors

In comparison to other aquaculture industries, the Norwegian aquaculture industry is well known worldwide as a provider of healthy, high-quality products and holds over 50% of the global market share for Atlantic salmon. The Norwegian aquaculture industry benefit from its oceanic and coastal environment as well as its resource pool for technology development and experience within aquaculture production. It can therefore be argued that due to Norway's high market share, their reputation and their production environment and expertise within the field, the threat of rivalry among existing competitors is low for the Norwegian aquaculture industry.

Threat of new entrants

Due to the high market share of the Norwegian aquaculture industry, their good reputation worldwide and their competitive advantages because of their oceanic and coastal environment, their resource pool for technology and their expertise within the field, it is difficult for new entrants to compete with the Norwegian aquaculture industry. Because of this combined with high investment costs it can be argued that the threat of new entrants is low for the Norwegian aquaculture industry.

Bargaining power of buyers

For the Norwegian aquaculture industry to remain the world's biggest provider of Atlantic salmon and to keep their reputation, they must comply with the requirements of their customers. Today, the market is experiencing a trend where the end customers are becoming more price-aware and more focused on their food being produced in a sustainable way. Therefore, the industry must focus on running a sustainable production to not lose their end customers as well as being competitive on price. However, since Norway possess such a great market share, other suppliers will not be able to satisfy the global demand without the Norwegian production. Therefore, the bargaining power of the buyers can be argued to be medium as not fulfilling the requirements of the customers may represent a relatively small loss of customers.

Threat of substitute products

The substitute products of Atlantic salmon are other sources of protein such as red meat, chicken and other types of fish. The customer's choice of protein is dependent on the availability of different sources, the price of different sources and the customer's own preference. The customer's preference may be affected by health trends and by the reputation of the Norwegian salmon. However, if for example

salmon should be regarded as an unhealthy food source for a period, such health trends are usually short-lived. However, since the customers of the Norwegian aquaculture industry is becoming more price-aware, the threat of substitutes can be argued to be medium because the industry is dependent on their products being available for the customers at a competitive price compared to other sources of protein.

Bargaining power of suppliers

The suppliers to the Norwegian aquaculture industry play an important role in the success of the industry due to their experience and high competence level. The suppliers include feed, fish health products and services, equipment technology, processing of products, packaging services, transport services and legal and business-related services. The supplier industry is responsible for a major part of the employment from the aquaculture industry and a major part of the contribution to the GDP from the Norwegian aquaculture industry. Therefore, it can be argued that the bargaining power of the suppliers are high as the industry is dependent on a highly skilled supplier industry (Olafsen et al., 2012).

4.1.8 SWOT-analysis

This section present a SWOT-analysis of the Norwegian aquaculture industry. The aim of this analysis is to identify the industry's strengths, weaknesses, opportunities and threats in a structured format. Figure 17 below present a summary of the SWOT-analysis.

Strengths	Weaknesses
- Well known reputation. - Good resource pool for technology development and high level of expertise. - Oceanic environment and coastal zone of Norway. - Small environmental footprint from production. - High global market share. - Access to the offshore-technology industry.	- Heavily regulated by the government. - Dependent on keeping their good reputation. - Dependent on not meeting international resistance and trade barriers. - Environmental influence from production especially because of sea-lice and escapes. - High production lead-time.
Opportunities	**Threats**
- World population growth and increased buying power in the middle class may lead to increase in demand. - Technological innovation. - New production areas offshore. - Draw knowledge from the offshore industry.	- Loss of reputation. - Introduction of new rules and regulations. - Increased environmental footprint of production because of sea-lice, escapes, emissions and pollution. - Loosing market shares. - Substitutes. - Political turbulence and trade barriers. - Not attracting sufficient talented personnel - Loosing key personnel. - Climate changes making production difficult. - More focus by the customers on food being produced in a sustainable way.

Figure 17: Summary of the SWOT-analysis

Strengths

One of the major competitive advantages of the Norwegian aquaculture industry is the good reputation of their products worldwide. The label "Norwegian salmon" is considered a seal of approval and therefore the reputation of their products is one of the industry's strengths. The market share of the Norwegian aquaculture industry is also one of its strengths as this accounts for over 50% of the global market. This high market share serve as an indicator of the quality of the Norwegian aquaculture production and reinforce the good reputation of the industry. Without this reputation, the industry would not manage to seize such a big market share.

Further, the industry has access to a good resource pool for technology development and Norway is one of the premier nations within the field of marine technology. The offshore-technology industry may also be considered one of the industry's strengths as this industry possess a lot of knowledge within the field of marine technology which the industry may benefit from accessing. Another strength of the Norwegian aquaculture is their production environment. The large coastal zone of Norway and its oceanic environment has made it possible for the industry to run such a big production in comparison to other nations and is one of the competitive advantages of the industry. Further, the production of the Norwegian aquaculture industry has a small environmental footprint in comparison to land-based food production.

Weaknesses

As one of the industry's strengths is their good reputation worldwide, one of their weaknesses is that the industry is dependent on keeping this reputation. Further, the industry is heavily regulated by the government. It is therefore necessary that the industry keep running a production that does not lower the quality of their products nor give the government incentives to introduce stricter rules and regulations. Another weakness of the industry is that since most its value creation come from export-incomes, it is dependent on not meeting international resistance and trade barriers. Therefore, the industry is dependent on stable political relationships with their trade nations.

Further, a weakness of the industry is the influence the production has on its surrounding environment. Even though the environmental footprint of the production is low in comparison to other land-based food production, the industry has a negative impact on its surrounding environment. The major issue is the effect of salmon-lice on the wild salmon stocks and the escape of cultivated salmon. Another weakness of the industry is their long production lead time of 3 years. The bottleneck is the growing period in the fish cages in the ocean which has a duration of between 14 and 22 months. The implication of this is that changes made today will not reach the market in 3 years and thus, the responsiveness of the value chain of the industry is low. This may weaken the industry's ability to handle change in the market situation.

Opportunities

An opportunity for the Norwegian aquaculture industry is the world population growth combined with increased buying power in the middle class. With the increase in world population, the global demand for food will rise and with the increased buying power in the middle class, it is likely that the demand for Norwegian salmon will rise. The countries considered to be of high future potential for the Norwegian aquaculture industry are Brazil, Russia, India, China and South Africa.

Further, technological innovations pose an opportunity for the Norwegian aquaculture industry. New technological innovations have the potential of reducing the environmental impact of the production, improve fish health and open new areas for production which previously were not suited. For development of new technology, the existing offshore industry in Norway also pose an opportunity for the aquaculture industry as this industry possess much knowledge and experienced personnel within the field of marine technology.

Threats

The industry losing their good reputation is a threat as they are dependent on their reputation to keep their market share. To avoid losing their good reputation, the industry must run an environmentally sustainable production as consumers are becoming more focused on their food being produced in a

sustainable way. Political turbulence and trade barriers are also threats that may cause a loss of market shares.

Another threat the industry is facing is the introduction of new rules and regulations by the government inhibiting its production and future growth. Such rules and regulations may be introduced as a reaction to the threat the industry is facing of having an increased environmental footprint of their production because of salmon-lice, escapes, emissions and pollution. Climate changes making production more difficult in the future is another threat the industry is facing along with not attracting sufficient talented personnel and losing key personnel. Further, if the industry is to continue to upscale their production, a threat is not gaining access to sufficient area and feed resources. The industry is also facing the threat of substitutes if they do not manage to keep their products available at a competitive price compared to other sources of protein.

4.2 Scenario planning analysis

This part of the thesis present a scenario planning analysis using the SRI approach. The input used in the analysis is the insight gained from the interviews and the information presented in Section 4.1. The output of the analysis is a set of scenarios for the Norwegian aquaculture industry in 2050 and a set of corresponding action plans. The scenarios and action plans are presented in Chapter 5.

4.2.1 Analysis of decisions and strategic concerns

In the interviews, the stakeholders were presented with the 2050-goals for the Norwegian aquaculture industry which were first presented in Section 4.1.4 and asked if they had any objections to these.

The first objection that was identified was that the goals do not include improving HSE within the industry. Today, the industry is ranked as number 2 in Norway of industries with the most working accidents, and the stakeholders who pointed out this lack of HSE-focus argued that if the industry does not address this, it may become the cause of restrictions of the industry's future growth. The next objection was that even though the industry aim at improving the health of the fish, due to the high mortality among farmed salmon they should in addition focus on the welfare of the fish. The last objection was that the goals should include introducing contemporary surveillance of the ocean and achieving a more knowledge-based management of the industry.

Since most the stakeholders interviewed did not have any objections to the goals, the strategic concerns of this scenario planning analysis are:

1. Increase the production of Norwegian salmon to a volume of 5 million tonnes.
2. Achieve a sustainable future development of the Norwegian aquaculture industry by:
    a. Reducing the number of escapes.
    b. Reduce the harmfulness of salmon-lice.
    c. Improve the fish health and welfare of the farmed salmon.
    d. Secure good access to and exploitation of feed resources.
    e. Increase the exploitation of waste from the aquaculture production.
    f. Achieve efficient area usage for production.
    g. Reduce emissions from the aquaculture production.
3. Continue to be a creator of job opportunities.

4.2.2 Identification of key decision factors

In the interviews, the stakeholders were asked to identify what factors they consider most important to consider when making decisions within the industry and what factors that affect the outcome of the decisions made. The identified decision factors are sorted according to the number of times each force was identified and presented in Table 3 below.

Table 3: Identified decision factors

Factor id.	Factors identified	Number of times
1	Income and economic growth	6
2	Environmental sustainability	4
3	Value creation in local communities	4
4	Political interests	3
5	Marketing and the reputation of the industry	3
6	Efficient production	2
7	HSE	1
8	New technology	1

As seen in Table 3, the factor that was most frequently identified was that the decisions should focus on generating income and economic growth within the industry. This factor was identified by all the stakeholders and was argued to be the most important factor as generating income and economic growth is the reason why actors enter the business. The second factor was that the decisions should focus on ensuring an environmentally sustainable development of the industry. This was identified by four of the six stakeholders and was argued to be a prerequisite to be able to achieve the goal of increased production volumes. The third factor was that the decisions should focus on creating value in the local communities. This factor was identified by four of the six stakeholders and was argued to be important as it may have a direct impact on the political will to allow the industry to upscale their production. The fourth factor identified was that the decisions should focus on complying with political interests. This factor was identified by half of the stakeholders and was argued to be important since the industry is strictly regulated and thus a future expansion is dependent on political will. Without political will, an expansion may be inhibited by the introduction new rules and regulations.

The fifth factor identified was that the decisions should focus on how they may impact the marketing and the reputation of the industry. This factor was identified by half of the stakeholders and argued to be important as the industry is dependent on keeping their good reputation internationally to avoid losing market shares and to be able to seize new market shares. The sixth factor identified was that the decisions should focus on ensuring an efficient production. This factor was identified by two of the six stakeholders and was argued to be important as it directly impact the industry's income and ability to increase their export. The seventh factor identified was that the decisions should focus on ensuring better HSE within the industry. This was identified by one of the stakeholders and was argued to be important as the high number of accidents within the industry may become an inhibiting factor for the industry's future growth. The eighth factor identified was that the decisions should focus on ensuring development of new technology. This factor was identified by one of the stakeholders and was argued to be important as the Norwegian aquaculture industry is a highly innovative industry.

As factors 1-5 were identified by half or more of the stakeholders, these serve as the key decision factors for this scenario planning analysis. Therefore, the key decision factors are:

1. Income and economic growth: When making decisions, the industry should choose actions that generate income and economic growth.

2. Environmentally sustainable development: When making decisions, the industry should choose actions that ensure an environmentally sustainable development.

3. Value creation in local communities: When making decisions, the industry should choose options that ensure value creation in the local communities by continuing to be a creator of job opportunities and to ensure political will to allow the expansion of the industry.

4. Political interests: When making decisions, the industry should choose actions that does not cause political resistance for further expansion of the industry.

5. Marketing and the reputation of the industry: When making decisions, the industry should choose actions that does not harm the reputation of their product internationally to avoid losing market shares and to be able to increase their export.

4.2.3 Identification of key environmental forces

In the interviews, the stakeholders were asked to identify what forces they thought may affect the future development of the industry. The forces identified were:

1. Salmon-lice: Salmon-lice was the most frequently identified force and was identified by half of the stakeholders. It was argued to be the most critical force as the issue of salmon-lice may inhibit the future growth of the industry. Salmon-lice are an issue as the increased amount of fish at the production sites increase the occurrence of salmon-lice in the area. The salmon-lice cause wounds to the salmon which may cause infections and problems with the salmon's salt balance. Since the aquaculture production increase the occurrence of salmon-lice, this force affect the industry as the salmon-lice at the production sites also affect the wild salmon stock. Therefore, strict rules and regulations are introduced by the government to protect the wild salmon stock (SN, 2015).

2.Demand: The next force identified by two of the stakeholders was the demand for Norwegian salmon. It is estimated by the UN that within 2050 the world population will have reached 9,7 billion people. This population growth will result in an increased demand for protein internationally and it is projected by the World Bank that by 2030, 62% of all consumed seafood will be farm raised. The increase in protein demand serve as a force for the Norwegian aquaculture industry as the customer´s preferred source of protein affect the demand for Norwegian salmon (UN, 2015, TheWorldBank, 2013).

3. Political forces: The next force identified by two of the stakeholders was political forces. The Norwegian aquaculture industry is heavily regulated by the government and there are several political stakeholders who have different agendas and concerns when decisions are to be made. Further, the political situation internationally affect the industry as it is dependent on not meeting trade barriers and international resistance.

4. Price development of Norwegian salmon: The price development of Norwegian salmon was identified as a force by two of the stakeholders. The future development of the Norwegian aquaculture industry is affected by the price development of Norwegian salmon as this directly affect their earnings. It was argued in the interviews that the price development of Norwegian salmon in comparison to other sources

of protein is especially important as this may increase the threat of substitutes and lower the demand for Norwegian salmon.

5. Environmental sustainability: Environmental concerns was identified as a force by two of the stakeholders and it was argued that the most important environmental concern is whether the industry manage to achieve a more environmentally sustainable production. Today, a greater focus has been placed by the government on environmental sustainability than what has been the case in the past. Therefore, if the industry does not manage to comply with environmental concerns, the future growth of the industry may become inhibited.

6. Customer preferences: The requirement of the customers that their food products shall come from an environmentally sustainable production was identified as a force by one of the stakeholders. It was argued that customers today are becoming more focused on their food being produced in an environmentally sustainable way. This requirement may affect the reputation of the industry and thus its market share.

7. Fish health: Fish health and the welfare of the farmed salmon was identified as a force by one of the stakeholders and it was argued that ensuring good health and welfare of the farmed salmon is a prerequisite to achieve the 2050-goals.

8. Area for production: Access to sufficient area for production was identified as a force by one of the stakeholders. It was argued that today, the aquaculture production occupies ocean space which could be used by other actors for different purposes. Therefore, if the industry is to expand their production, access to more area for production is a necessity.

9. Technology innovation: The ability for technology innovation was identified as a force by one of the stakeholders. It was argued that new technological innovations may solve many of the issues the industry is facing today and that solving these issues is a necessity if the industry is going to reach the 2050-goals.

10. Ability of the actors to communicate: The ability of the actors to communicate was identified as a force by one of the stakeholders. It was argued that today, the media is playing an increasingly important role within industries and that many politicians today are affected by what they see in the media. Therefore, the industry's ability to communicate efficiently in these arenas may affect the future development of the industry.

11. Consolidation within the industry: The degree of consolidation within the industry was identified as a force by one of the stakeholders. It was argued that if the industry is to succeed in offshore aquaculture at more exposed locations, a consolidation of companies within the industry is necessary as the investment costs are high. Therefore, the degree of consolidation may affect the achievement of offshore aquaculture and thus the development of the industry.

12. Access to feed-resources: Access to sufficient feed-resources was identified as a force by one of the stakeholders. It was argued that if the industry is to reach its goals of increased production it cannot longer depend on feed-resources that occupy land-based production areas. Instead, it was argued that the industry should close the production cycle in the ocean by harvesting marine resources on a lower tropical level for feed production.

4.2.4 Analysis of key environmental forces

In the interviews, the stakeholders were asked to rate the degree of uncertainty for each force and the potential influence each force may have on the industry as low, medium or high. The resulting answers are presented in Table 4 below.

The twelve forces identified during the interviews can be divided into four groups of sub-forces as seen in Figure 18 below. The first group is environmental forces and include salmon-lice, environmental sustainability, fish health and access to feed-resources. The second group is political forces and include political influence and the ability of the actors to communicate. The third group is market forces and include demand, price development and customer preferences. The last group is industrial forces and include area for production, technology innovation and the degree of consolidation within the industry.

Table 4: Identified key environmental forces

Force id.	Forces identified	Number of times identified	Ratings of uncertainty	Ratings of impact on the industry
1	Salmon-lice	3	M, H, M	M, H, H
2	Demand	2	L, M	M, H
3	Political influence	2	H, M	H, M
4	Price development of Norwegian salmon	2	H, L	L, M
5	Environmental sustainability	2	H, H	H, H
6	Customer preferences	1	H	H
7	Fish health	1	L	H
8	Area for production	1	H	H
9	Technology innovation	1	H	H
10	Ability of the actors to communicate	1	H	H
11	Consolidation within the industry	1	H	M
12	Access to feed-resources	1	H	H

L: Low, M: Medium, H: High

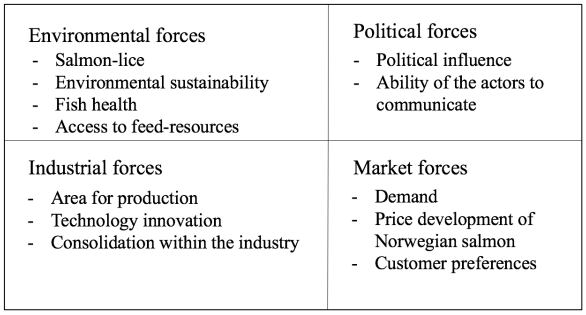


Figure 18: Categorization of key environmental forces

To evaluate the importance of each force-group, each sub-force has been given a priority ranking with respect to uncertainty and potential impact on the industry where high is given the value 3, medium 2 and low 1. To account for the difference in frequency of how many stakeholders who identified the different forces, Formula 1 as shown below has been used. By using Formula 1, the number of stakeholders who identified the different forces is part of the evaluation when determining the importance of them. The force-group that contain the force with the highest ranking with respect to uncertainty and potential impact will receive the highest priority when creating the scenarios. It is possible to evaluate the importance of the forces by using their average rating as shown in Appendix A.3. However, by using an average approach a high identification frequency of a force does not increase the importance of the force.

Formula 1: Key environmental force priority ranking formula

$$Priority\ ranking = \frac{Number\ of\ times\ identified}{Number\ of\ interviews\ performed} \times \Sigma \text{Individual ratings}$$

The results of the priority rankings for each force are presented in tables 5-8 below and the prioritization of the force-groups are presented in Figure 19 below. The force-group that received the highest ranking for both uncertainty and potential impact was the environmental forces. The group that ranked as number two was the political forces. The group that ranked as number three was market forces and the group with the lowest ranking was the industrial forces.

As presented in Table 5 below, the force within the environmental force-group that received the highest ranking was salmon-lice, followed by achieving environmental sustainability. This is not surprising, as salmon-lice is today considered to be one of the biggest challenges the industry is facing. As argued in the PESTEL-analysis in Section 4.1.6 and the SWOT-analysis in Section 4.1.8, the oceanic environment and coastal zone of Norway is one of its advantages and an increased environmental footprint was argued to be a threat. Another reason why the environmental forces has received such a high rating is because the effect these forces may have on the development of the industry. Since the industry is heavily regulated by the government, it is likely that by not handling the environmental forces, the industry will become subject to the introduction of new rules and regulations which may inhibit future growth.

Within the political force-group, political influence received the highest ranking as seen in Table 6 below. As argued in the PESTEL-analysis in Section 4.1.6, the industry is dependent on political will to achieve their goals of increased production. This is further supported in the SWOT-analysis in Section 4.1.8 where the heavy regulation by the government, the introduction of new rules and regulation and the dependency on not meeting international resistance and trade barriers were argued to be weaknesses and threats to the industry. Therefore, it is not surprising that the political forces were ranked as the second most important force-group.

Within the market force-group, the highest ranked force was the price development of Norwegian salmon followed by the demand as seen in Table 7 below. It is not surprising that the market forces were ranked as the third most important force-group. As argued in the PESTEL-analysis in Section 4.1.6, the industry is dependent on the relationship between the production price and the sales price of their product. This is further supported in the competitive force analysis in Section 4.1.7 where it is argued that the industry is dependent on their products being available for the customers at a competitive price compared to other sources of protein. In the SWOT-analysis in Section 4.1.8, it is argued that a weakness of the industry is its dependence on keeping its good reputation to maintain the demand of their products. Further, the customer's preferences for a more sustainable production of their food, loss of reputation and loosing market shares were argued to be a threat to the industry.

As seen in Table 8 below, the industrial forces received the lowest ranking of the force-groups and all the sub-forces identified within the group received approximately the same low score. That technological forces received such a low ranking in comparison to the other force-groups is somewhat surprising. However, as it was argued in the interviews and in the PESTEL-analysis in Section 4.1.6, Norway possess a good resource pool for technology development. This is supported by the competitive force analysis in Section 4.1.7 and is highlighted as a strength of the industry in the SWOT-analysis in Section 4.1.8. This optimistic view of the industry's own capabilities may explain why the industrial forces receive such a low ranking in comparison to the other force-groups as the general impression

gained from the interviews was that it is unlikely that the industry does not manage to develop the technological solutions necessary to reach the 2050-goals.

Based on the priority ranking of the different forces, the priority of the different force-groups when creating the scenarios are as presented in Figure 19 below. The force-group that will receive high priority is the environmental forces. The political forces and market forces will receive medium priority and the industrial forces will receive low priority.

Table 5: Ranking of environmental forces

Environmental forces	Uncertainty rating	Impact rating
Salmon lice	3,5	4
Environmental sustainability	2	3
Fish health	0,2	0,5
Access to feed-resources	0,5	0,5
Maximum	3,5	4

Table 6: Ranking of political forces

Political forces	Uncertainty rating	Impact rating
Political influence	1,7	1,7
Ability of the actors to communicate	0,5	0,5
Maximum	1,7	1,7

Table 7: Ranking of market forces

Market forces	Uncertainty rating	Impact rating
Demand	1	0,8
Price development of Norwegian salmon	1,3	1
Customer preferences	0,5	0,5
Maximum	1,3	1,0

Table 8: Ranking of industrial forces

Industrial forces	Uncertainty rating	Impact rating
Area for production	0,5	0,5
Technology innovation	0,5	0,5
Consolidation within the industry	0,5	0,3
Maximum	0,5	0,5

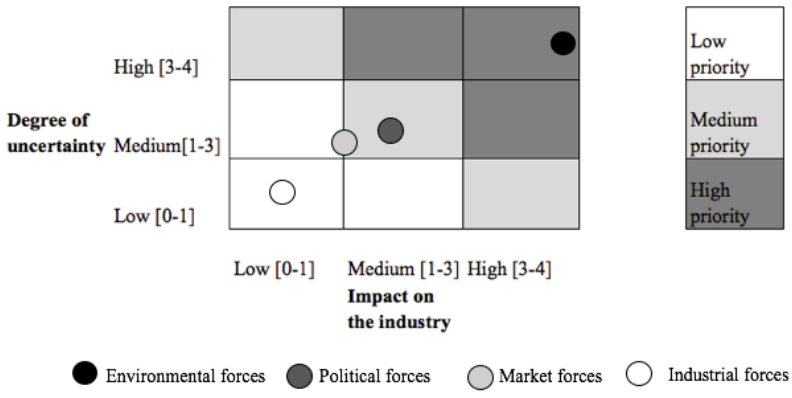


Figure 19: Key environmental force priority

4.2.5 Definition of scenario logics

In this section, the scenario logics which serve as the basis for the scenarios are created. To do this, a cross-impact analysis has been performed to identify what influence the different forces have on each other and to identify what force-groups that will be the critical drivers of change within the scenarios. Next, in what directions each force may develop have been identified. These directions are used to perform a morphological analysis from which the themes for the scenarios are selected.

Cross-impact analysis

Figure 20 below present the cross-impact analysis of the force-groups identified in Section 4.2.4. In the analysis, F1 = Environmental forces, F2 = Political forces, F3 = Market forces and F4 = Industrial forces. A rating of 0 imply that the force-groups are independent, a rating of 1 imply that they are dependent, a rating of 2 imply that the force-group has a slight impact on the other force-group and a rating of 3 imply that the force-group is a strong driver of the other force-group. The force-groups that in the cross-impact analysis received the highest score and will be the critical drivers of change within the scenarios are the political forces and the environmental forces.

	F1	F2	F3	F4	Score	
F1		3	1	1	5	F1: Environmental forces
F2	2		1	3	6	F2: Political forces
F3	0	1		2	3	F3: Market forces
F4	2	1	0		3	F4: Industrial forces

0: Independent 1: Dependent
2: Slight impact 3: Strong driver
Highest score: **F1 and F2**

Figure 20: Cross-impact analysis of key environmental force-groups

In the cross-impact analysis, the environmental forces are considered a strong driver of the political forces as the political will to allow an upscaling of the industry's production is directly dependent on the development of the environmental forces. A negative development of the environmental forces is likely to cause the introduction of new rules and regulations and fewer development concessions which will inhibit the growth of the industry. Further, the market forces are considered dependent on the development of the environmental forces. The reason for this is because the demand, price development and customer's preference is influenced by how the industry handle the environmental forces. The industrial forces are also considered dependent on the environmental forces as the available area for production is influenced by the salmon-lice situation.

The political forces are considered to have a slight impact on the environmental forces as the political forces may influence the required effort to solve the environmental issues and thus affect the environmental forces. The market forces are considered dependent on the political forces as the political forces can impact the demand, price development and the customer's preference. If politics is conducted in a way that the market does not approve of, the result of this may be trade barriers and international resistance. Further, the political forces are considered a strong driver of the industrial forces as it is the government that is responsible for giving concessions for production. Through these concessions, the government has a big influence on where the production is to take place. If these concessions are granted so that the industry must move its productions to more exposed locations, this will affect the need for technology innovation. This may also affect the degree of consolidation as the required investment costs to achieve offshore production may be too high for several individual companies today.

The market forces are considered not to have an impact on the environmental forces and they are considered independent in this analysis. The reason for this is because if for instance the demand for Norwegian salmon should drop, this will not have a direct effect on the salmon-lice situation. The political forces are considered dependent on the market forces. If for instance the customer's preference should shift from Norwegian salmon, the politicians would have to come up with measures to shift the customer's preference back to salmon from the Norwegian market. Further, the market forces are of slight impact on the industrial forces as an increase in demand for instance will lead to an increase in necessary area for production. This may result in an increased need for technology innovation and more consolidation within the industry if the production must be moved offshore.

The industrial forces are considered of slight impact on the environmental forces. The reason for this is that both moving the production to new locations and technology innovation may directly affect the salmon-lice situation, the degree of environmental sustainability and the health of the fish. The political forces are considered dependent on the industrial forces as change within the industrial forces such as achieving exposed aquaculture and thus reducing the issue of salmon-lice will affect the political view of the industry. The market forces are considered independent of the industrial forces as achieving exposed aquaculture for instance do not directly affect the demand, price development nor the customer's preference.

Development options for the key environmental forces

To perform a morphological analysis of the key environmental forces, a set of different development options has been decided.

F1: Environmental forces: The environmental force-group consist of salmon-lice, environmental sustainability, fish health and access to feed-resources. In the morphological analysis, the development options for this force-group will be 1) Improved meaning a decrease in the negative impact of the forces on the industry, 2) Unchanged meaning that the forces will have the same effect on the industry as is the case today and 3) Worsening meaning that the forces will have an increased negative impact on the industry.

F2: Political forces: The political force-group consist of political influence and the ability of the actors to communicate. In the morphological analysis, the development options for this force-group will be 1) Improved meaning that the political forces have a favourable impact on the industry, 2) Unchanged meaning that the political forces affect the industry in the same way as is the case today and 3) Worsening meaning that the political forces have a negative impact on the industry and inhibit the future growth.

F3: Market forces: The market force-group consist of demand, price development of Norwegian salmon and customer's preference. In the morphological analysis, the development options for this force-group will be 1) Rise meaning that there is a rise in demand for Norwegian salmon, a positive price development of Norwegian salmon and a rise in customers that prefer Norwegian salmon. The next development option will be 2) Unchanged meaning that the market forces will remain unchanged from what they are today. The last development option will be 3) Fall meaning that there will be a fall in demand for Norwegian salmon, a negative price development of Norwegian salmon and a negative shift in the customer's preferences.

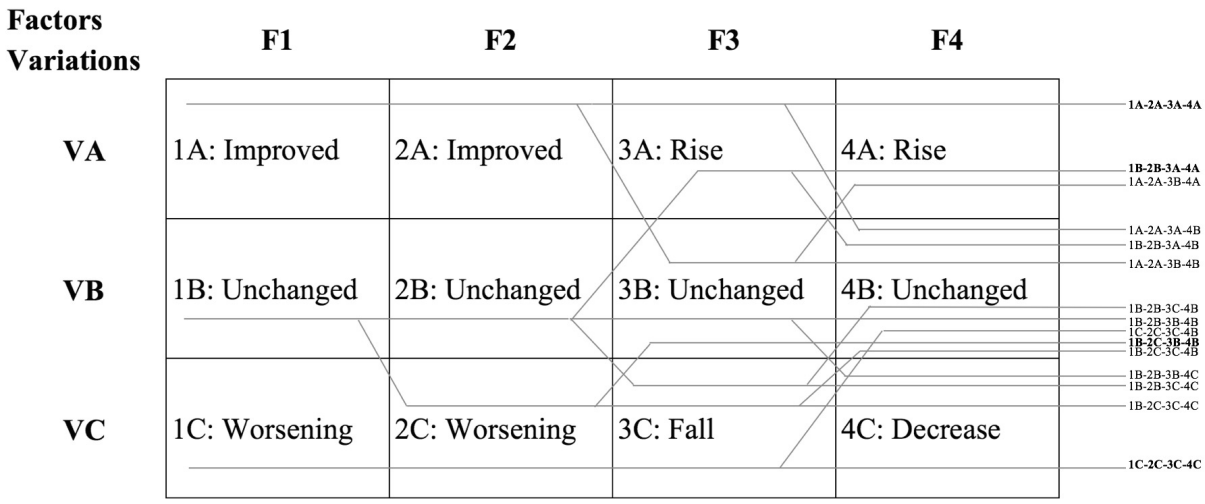
F4: Industrial forces: The industrial force-group consist of area for production, technology innovation and consolidation within the industry. In the morphological analysis, the development options for the

industrial forces will be 1) Rise meaning that there will be a rise in the available area for production, a rise in the level of technology innovation and more consolidation within the industry. The next development option will be 2) Unchanged meaning that the industrial forces will remain unchanged from what they are today. The last development option will be 3) Decrease meaning that there will be a decrease in the available area for production, stagnation in the degree of technological innovation and no consolidation within the industry.

Morphological analysis and scenario theme selection

The morphological analysis in Figure 21 below is performed to visualize the plausible combinations of factor variations and to create a basis for selecting the themes for the scenarios. To determine what combinations are plausible, the cross-impact analysis performed in this section has been used as a basis. In the morphological analysis, all the different force-groups have been assigned with three different factor variations and the lines represent one plausible combination of factor variations.

From the morphological analysis, four scenario themes have been selected as seen in Table 9 below and these are marked in bold in Figure 21. These themes form the basis for the future developments in the different scenarios. To ensure that the scenarios created capture a wide range of possible future developments, both the best-case and worst-case variation of factor combinations are chosen. These are 1A-2A-3A-4A and 1C-2C-3C-4C respectively. The last two themes selected are the combinations 1B-2B-3A-4A and 1B-2C-3B-4B. These are chosen to explore both a positive future development and a negative development within the interval of different scenario themes.



F1: Environmental forces, F2: Political forces, F3: Market forces, F4: Industrial forces

Figure 21: Morphological analysis of environmental force-groups

Table 9: Scenario theme selection

Scenario number	Scenario ID	Environmental force development	Political force development	Market force development	Industrial force development
1	1C-2C-3C-4C	Worsening	Worsening	Fall	Decrease
2	1B-2C-3B-4B	Unchanged	Worsening	Unchanged	Unchanged
3	1B-2B-3A-4A	Unchanged	Unchanged	Rise	Rise
4	1A-2A-3A-4A	Improved	Improved	Rise	Rise

5 Results

The results of the scenario planning analysis performed is a set of scenarios and corresponding action plans. The scenarios are presented in Section 5.1 and the action plans are presented in Section 5.2. A summary of the scenarios and action plans is presented in Section 5.3 together with a list of factors for monitoring that may disclose whether the development of the industry is moving towards one of the different scenarios.

5.1 Scenarios

The scenarios created are named Dry Well, Puddle, River and Poseidon, and are all elaborations of the scenario themes selected in Chapter 4.2.5. The scenarios describe future states for the Norwegian aquaculture industry in 2050 ranging from a very dissatisfactory future state to a very satisfactory one.

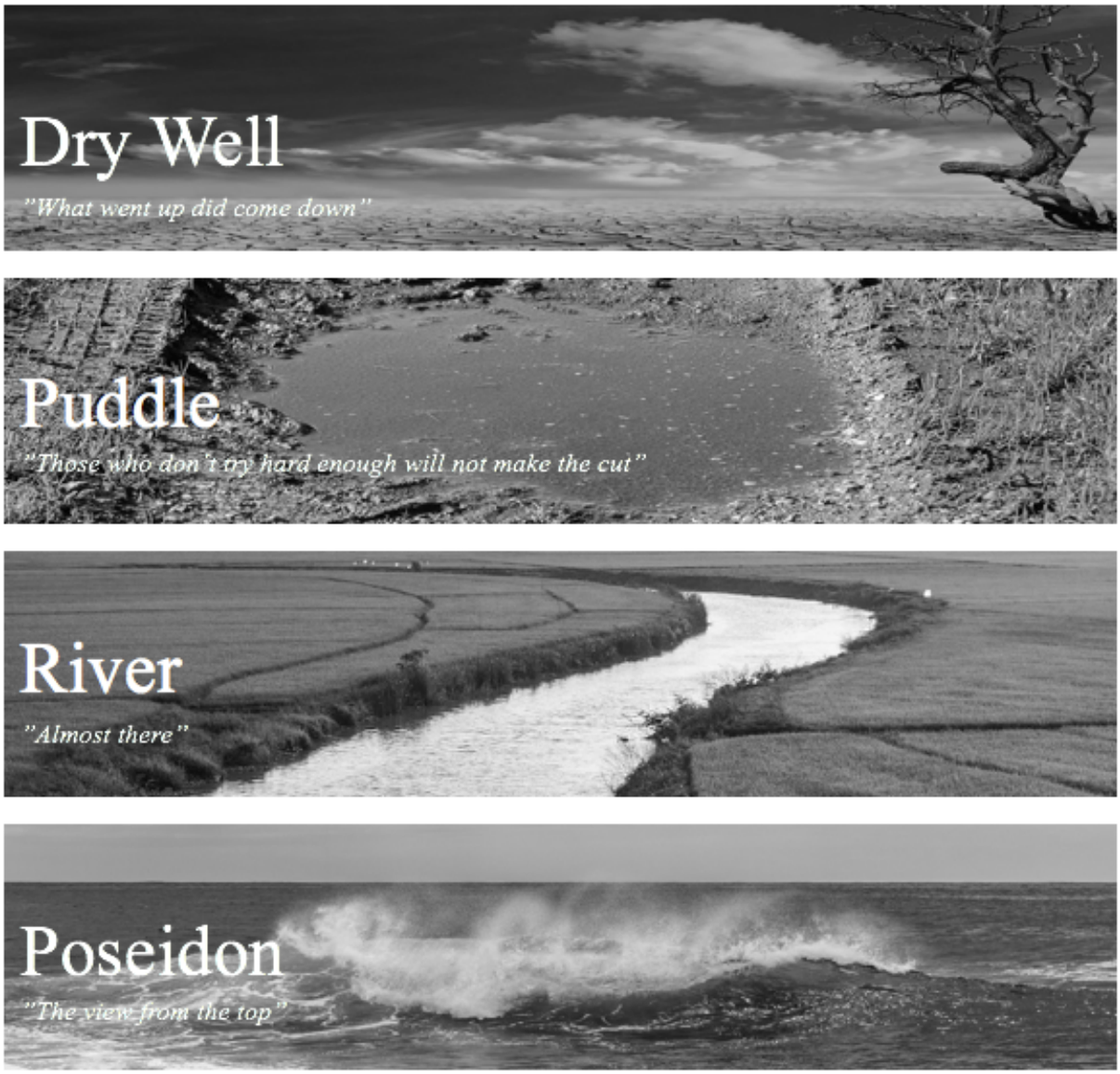


Figure 22: Illustrative images for the scenarios (Pixbay, 2017a, Pixbay, 2017c, Pixbay, 2017d, Pixbay, 2017b)

5.1.1 Dry Well

In Dry Well, the Norwegian aquaculture industry has experienced major downturn in their production levels and turnover. Compared to the Norwegian aquaculture industry's export volume of 1 million tonnes in 2016, the export volume now is only 150.000 tonnes. The main reason for this downturn is the environmental forces that the industry was facing in 2017.

In 2017, the industry was facing several challenges related to the environmental forces. The biggest challenge was salmon-lice. In addition, the industry was struggling with gaining sufficient access to feed-resources and a poor fish health among the salmon in the fish farms. The industry did not manage to solve any of these issues by 2050 despite their attempts to do so and this had a major ripple effect. This ripple effect was greatest for the political forces as the damaging environmental impact of salmon-lice on the wild salmon stock increased so much that the government had to act attempting to reduce the issue. Therefore, less development concessions were granted and new rules and regulations were introduced. Since these actions made it more difficult for the actors to run production and made it difficult for the industry to upscale their production, the industry experienced a reduction in their production levels.

The ripple effect of the poor handling of the environmental forces also affected the market forces. Since fish health and salmon-lice has become such a big issue in Dry Well, the Norwegian salmon has lost its reputation of being a healthy high quality product. This has led to a shift in the customer's preferences and thus, the demand for Norwegian salmon has dropped significantly. This drop of demand has caused the industry to lose a considerable part of their market share. Further, since the Norwegian salmon has lost its good reputation, the price of Norwegian salmon has plummeted.

Due to the reduction in demand, the reduced number of development concessions and the strict rules and regulations, several actors both within the seafood industry and the supplier industry has gone out of business which has left many people unemployed. It has also led to fewer people having faith in the earning potential of entering the industry, thus few actors dare to enter the industry. This has caused the industry to now consist of smaller local actors who do not have the necessary means to fund development of new technology that might improve the situation.

Therefore, in Dry Well, what once was a promising growing industry and a major employer has now become insignificant in comparison to other industries in Norway. This development can be seen in Figure 23 below which illustrate the export volume from the Norwegian aquaculture industry in Dry Well.

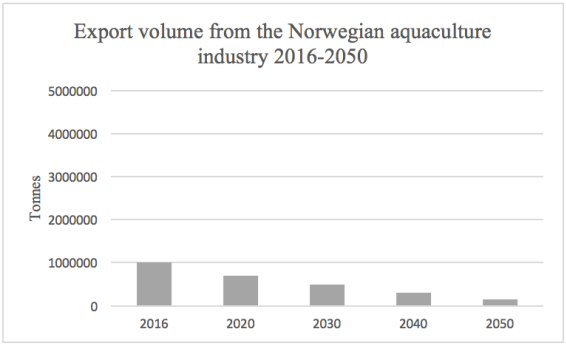


Figure 23: Export volume from the Norwegian aquaculture industry in Dry Well

5.1.2 Puddle

In Puddle, the growth of the Norwegian aquaculture industry peaked in year 2020 and then stagnated. Now, the export volume from the Norwegian aquaculture industry is 950.000 tonnes.

The main reason for this stagnation is that despite efforts to solve the environmental issues the industry was facing in 2017, there has been no improvement with respect to any of the environmental forces. The biggest environmental issue is still salmon-lice as technology innovations to physically remove salmon-lice has proven unsuccessful. Therefore, salmon-lice are still treated using medication and the issue of salmon-lice becoming immune to treatment is still present. Further, due to the amount of attention the issue of salmon-lice has received, the industry has not managed to improve the fish health in their fish pens, not developed a more sustainable way for feed-production nor managed to gain a more environmentally sustainable way of production. Since the industry has not managed to solve the environmental issues, the industry has met political resistance. The government has stopped giving development concessions and will not allow an upscaling until the industry can prove that they are able to handle the environmental issues. This is done as a preventive measure to secure the health of the wild salmon stock.

The demand for Norwegian salmon in Puddle has remained unchanged despite the population growth. The reason for this is that even though the global demand for salmon has increased, the Norwegian aquaculture industry has not been able to upscale their production to profit on this increase in demand. Therefore, new actors have managed to seize the market shares that the industry regarded to be of high potential in 2017. Further, the new actors that have entered the market has managed increase the supply of salmon in the market in line with the increasing demand and thus, the price of Norwegian salmon has remained unchanged.

Since the government has introduced a stop in development concessions due to the issue of salmon-lice, the industry has not prioritized gaining more area for production. They have conducted research on achieving exposed aquaculture attempting to reduce the issue of salmon-lice, however, these attempts have proven unsuccessful.

Therefore, in Puddle the industry is inhibited to grow until they have managed to prove that they are able to handle the environmental issues of running their production. Figure 24 below illustrate the export volume from the Norwegian aquaculture industry in Puddle.

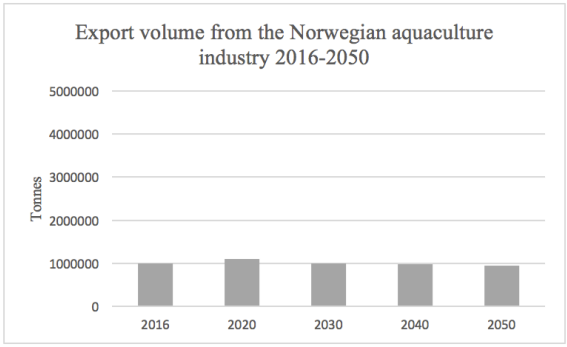


Figure 24: Export volume from the Norwegian aquaculture industry in Puddle

5.1.3 River

In River, the Norwegian aquaculture industry has experienced a big growth in their production levels and the export volume from the Norwegian aquaculture industry is 2.110.000 tonnes. This is an increase of 1.110.000 tonnes compared to 2016. However, the industry has not managed to reach their 2050-goals.

The main reason the industry has not managed to increase their production to the level they aimed at for 2050 is because the industry has not yet managed to handle the environmental issues in a satisfactory way. The industry has devoted much funding for technology development and have successfully managed to move production to more exposed locations. By doing so, the issue of salmon-lice as well as the issue of not having sufficient area for production is eliminated at these locations. However, due to the high costs of offshore production, only the larger companies afford doing this. Therefore, it is the large seafood companies that can afford to run offshore production that is responsible for most of the increase in the export volumes. At the locations near the shore, salmon-lice are still a pressing issue and the companies operating at these locations still are subject to strict rules and regulations by the government.

Since the industry has still not managed to solve the issue of salmon-lice at their locations near the shore, the political forces are restraining the development of the industry. In River, the rules and regulations the companies must comply with are stricter for the companies that wish to produce near the shore than for those who produce at exposed locations. Therefore, the smaller companies are struggling with upscaling their production and thus, the industry has not yet reached their goal of increased production.

Due to good marketing efforts by the industry and the increase in world population, the demand for Norwegian salmon has increased and the industry has successfully seized new market shares. The industry is now the main exporter of salmon to India, Russia and South Africa. The marketing efforts made by the industry has also successfully improved the reputation of the Norwegian salmon and thus the products from the Norwegian aquaculture industry is a highly-desired product among the customers of cultivated salmon. This combined with an increase in demand and that the upscaling of production is not sufficient to fulfil the increased demand, the price of Norwegian salmon has increased.

Therefore, in River the industry can upscale their production at offshore locations, but smaller actors who are not able to invest in equipment for offshore production are inhibited by rules and regulations. Figure 25 below illustrate the export volume from the Norwegian aquaculture industry in River.

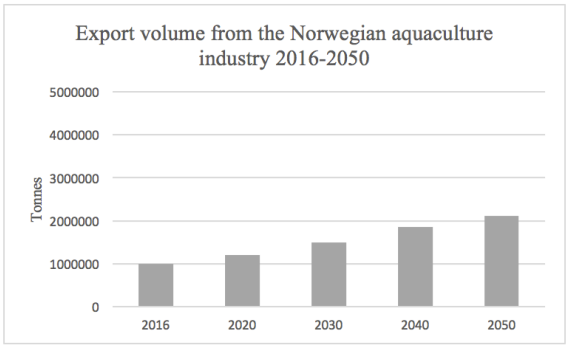


Figure 25: Export volume from the Norwegian aquaculture industry in River

5.1.4 Poseidon

In Poseidon, the Norwegian aquaculture industry has reached all their 2050-goals and now the export volume of farmed salmon has reached 5 million tonnes. This positive development has several reasons, but the most important one is the choice the industry made in 2018 to increase the attention on making the industry environmentally sustainable and to in collaboration solve the environmental issues of the industry.

This choice to collaborate proved very successful and had many positive effects. The first and most important one is that the industry successfully achieved exposed aquaculture and more effective lice-treatment by devoting more funding for technology development. This new technology allowed the industry to start production at more exposed locations that previously were unfit for salmon production whilst simultaneously ensuring a good fish health among the farmed salmon at these locations. This has eliminated the issue of not having sufficient area available to upscale their production. With the new lice-technology, the industry managed to eliminate the issue of the salmon-lice becoming immune to medical treatment as it uses lasers to remove the lice. This allowed the industry to upscale the production at their shore-based sites. Further, the industry managed to close the production cycle in the ocean by developing feed that was made from marine resources and thus not exploiting land-based resources in their feed production.

Achieving a more environmentally sustainable profile and increasing the production was made possible for two reasons. The first reason is the political will that emerged when the industry made the choice to more actively focus on solving the environmental issues in collaboration. The second one is the increased degree of consolidation within the industry to cope with the high costs of technology research and development.

In Poseidon, the improved profile of the industry with respect to environmental sustainability has affected the market forces greatly. Due to the increased focus among customers that their food shall be produced in a sustainable way, the demand for Norwegian salmon has increased and the industry has been able to seize new market shares. Now, in addition to the nations the industry previously exported to, they have become the main exporter to Brazil, Russia, India, China and South Africa. Further, the price of the Norwegian salmon has increased as the industry has devoted much funding in marketing of the Norwegian salmon as a brand which has made the Norwegian salmon a highly-desired product.

The achievement of increased production levels has in addition led to the creation of many new job opportunities within the seafood industry and the supplier industry and the Norwegian aquaculture industry has become one of the major employers in Norway. Figure 26 below illustrate the export volume from the Norwegian aquaculture industry in Poseidon.

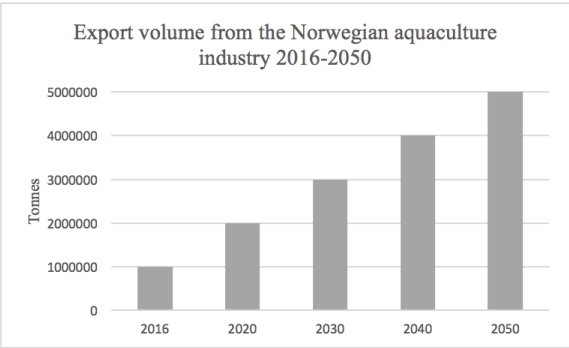


Figure 26: Export volume from the Norwegian aquaculture industry in Poseidon

5.2 Action Plans

The action plans presented in this section are intended to describe the implications of the scenarios with respect to the key decision factors, determine whether the information about the future validate the original assumptions, determine what the scenarios imply for the design and timing of strategies, describe what threats and opportunities the scenarios suggest, describe what critical issues that emerge from the scenarios, determine which cases that deserve to be addressed by specific contingency plans, determine what kind of flexibility and resilience that is necessary from the industry's planning perspective and determine what factors that deserve monitoring.

5.2.1 Dry Well

In Dry Well, the way the key decision factors have been prioritized has had severe implications on the development of the industry. The most critical area where the industry has failed is with respect to choosing actions that ensure an environmentally sustainable development of the industry. This has caused ripple effects making any effort made by the industry to comply with the other key decision factors useless. Therefore, the key decision factors should change priority so that ensuring an environmentally sustainable development receive a higher priority than income and economic growth.

The information about the future in Dry Well do validate the original assumptions about proposed decisions as the scenario show the effect failure to fulfil the aim of the key decision factors may have on the development of the industry. However, the scenario describes the worst-case situation where the industry experience a worsening in the environmental situation despite attempts to improve it and it can therefore be argued how likely the scenario is. For the design and timing of the strategies, the scenario suggest that the strategies should be designed so that they contain specific plans of how to handle a worsening in the different force-groups that affect the industry.

The threats this scenario suggest is not handling the issue of salmon-lice, not gaining sufficient access to feed-resources, poor fish health, reduction in development concessions, new rules and regulations, loss of reputation, shift in customer's preferences, decrease in demand, loss of market share, negative price development, actors going out of business and higher barriers for actors who want to enter the business. As this scenario describe the worst-case development of the industry, there are no opportunities that the industry may seize.

The critical issue that emerge from this scenario is the damaging effect a worsening in the environmental situation may have on the industry. The result of such a worsening may be a direct cause of a worsening of the other forces that affect the industry. Therefore, the case that deserve to be addressed by specific contingency plans is the environmental issues and especially the issue of salmon-lice as this is the most critical driver.

The Dry Well scenario suggest that the industry should create a strategy that is flexible enough to quickly be altered to handle changes in the force-groups that affect the industry. The strategy should also be resilient to handle a worsening of the different force-groups. This scenario serve as a good example of how the industry may experience a downturn if they do not prepare for a worsening of the different force-groups that affect the industry.

The factors for monitoring that may disclose whether the industry is developing towards the future state described in the Dry Well scenario are the efficiency of salmon-lice treatment, access situation of feed-resources and development of fish health among the cultivated salmon.

5.2.2 Puddle

In Puddle, the handling of the key decision factors has had negative implications on the development of the industry. The industry has failed to choose actions that ensure an environmentally sustainable development and thus the environmental situation has remained unchanged. This has affected the political will to upscale the production and the political force-situation has worsened because of this. Therefore, since the environmental force-group has such a major effect on the other force-groups, the key decision factor aiming at ensuring an environmentally sustainable development should receive a higher priority than income and economic growth. The industry should also make political interests a higher priority to avoid facing political resistance.

The information about the future in Puddle do validate the original assumptions about proposed decisions as the scenario show how the faith in the industry may decrease if they do not fulfil the aim of the key decision factors. In Puddle, the political force-situation worsens as the politicians lose faith that the industry will be able to solve the environmental issues. The Puddle scenario therefore suggest that the strategies of the industry should be designed so that they account for the impact the different force-groups have on each other. The strategies should also consider the effect of not achieving change within a force-group.

The threats this scenario suggest are not achieving improvement of the salmon-lice situation, not improving the fish health of the cultivated salmon, not manage to develop a more sustainable way for feed-production, not manage to develop a more sustainable way of production, political resistance, stop in development concessions and new actors seizing market shares. The opportunities this scenario suggest is achieving exposed aquaculture and thus possibly handle the issue of salmon-lice and regaining political will for an upscaling of the production. Further, the global increase in demand for salmon pose an opportunity for the Norwegian aquaculture industry in Puddle.

The critical issue that emerge in the scenario is not achieving improvement of the environmental issues that arise because of the industry's production and the loss of political will to upscale the production. Since the production affect the surrounding environment, an upscaling of the production is dependent on the industry demonstrating that they can do this without further harming the surrounding environment. Therefore, the special case that deserve to be addressed by specific contingency plans is how the industry is going to solve the environmental issues and especially the issue of salmon-lice. This plan should also contain a strategy of how the industry is going to communicate to the public what actions they are making to solve the environmental issues to ensure that political will for an upscaling is present.

The Puddle scenario suggest that the industry should create a flexible strategy that can quickly be altered to account for change in the forces that affect the industry and that the strategies should be resilient for changes within the different force-groups so that they have concrete plans to handle a worsening within the different groups.

The factors for monitoring that may disclose whether the industry is developing towards the future state described in the Puddle scenario are improvement in occurrence of salmon-lice, improvement in fish health, degree of sustainability of the feed-resources and the public view of the industry.

5.2.3 River

In River, the industry has successfully chosen actions that generate income and economic growth and thus benefited from the experienced growth in demand for salmon. They have also successfully prioritized marketing and the reputation of the industry which has enabled them to successfully seize new market shares and improved the reputation of the Norwegian salmon. However, they have not made environmental sustainability a high enough priority to achieve change, and thus the political situation has remained unchanged for the companies who cannot afford to start production at exposed locations. Therefore, the implication of the River scenario on the key decision factors is that the industry should make environmental sustainability a higher priority than income and economic growth. The industry should also make political interests a higher priority to ensure a political will to upscale the production at the locations close to the shore.

The information about the future in River do validate the original assumptions as the scenario show how prioritizing economic growth and marketing in a situation with an increase in world population and demand result in increased income for the industry. The scenario also show how not prioritizing environmental sustainability enough may cause a lack of political will and thus inhibit the growth of the industry. The scenario therefore suggest that the strategies should be designed so that they continuously monitor the way the market is developing and therefore can initiate marketing efforts at strategic times. Further, the industry should design their strategy so that it accounts for the inhibiting effect not improving the environmental issues along the shore may have on the growth of the industry.

The threats the scenario suggest are salmon-lice, high costs of production at exposed locations, strict rules and regulations for companies operating close to the shore and smaller companies struggling to upscale their production. The opportunities suggested are the achievement of exposed aquaculture, increase in world population, increase in demand for Norwegian salmon, seizing of new market shares, improved reputation of the Norwegian salmon and a positive price development of the Norwegian salmon.

The critical issue that emerge in the River scenario is that the industry has not managed to improve the environmental issues at the locations close to the shore. Since the investment costs to start exposed aquaculture are high and the rules and regulations for production near the shore are strict, smaller companies struggle with upscaling their production. Therefore, the special case that deserve to be addressed by specific contingency plans is improving the environmental issues at the production sites near the shore where salmon-lice receive the highest priority and lowering the cost of starting exposed aquaculture.

The River scenario suggest that the industry should create a strategy that is resilient to a worsening of the political force-group as there is a likelihood that the industry may experience a worsening of the political will if they do not manage to solve the environmental issues at the production locations near the shore.

The factors for monitoring that may disclose whether the industry is developing towards the future state described in River is the degree of technology innovation, the development of the market situation, customer´s preferences, the price development of the Norwegian salmon, the occurrence of salmon-lice at production locations near the shore and the public view of the industry.

5.2.4 Poseidon

In Poseidon, the industry has successfully managed to comply with all the key decision factors. They have generated increased income and economic growth, managed to make their production more environmentally sustainable, created new job opportunities, ensured political will for upscaling and improved the reputation of the industry by keeping marketing a high priority. This has led to the industry reaching all their 2050-goals. However, this development was made possible because the industry made a choice to make environmental sustainability a high priority. The implications of the Poseidon scenario on the key decision factors is therefore that environmental sustainability should receive a higher priority than income and economic growth.

The information about the future in the scenario do validate the original assumptions as the scenario show the importance of complying with the key decision factors. In Poseidon, the industry experience a positive development of all the force-groups that affect them. This would not have been the case if the industry did not comply with the key decision factors. Therefore, the scenario imply that the strategies of the industry should be designed so that they account for all the key decision factors and how they affect the force-groups.

Since the industry in Poseidon has experienced the best-case development, the scenario does not suggest any threats. The opportunities the scenario suggest are collaboration within the industry to solve the environmental issues, achieving exposed aquaculture, consolidation within the industry to cope with high costs of exposed aquaculture, development of new technology for salmon-lice treatment, new areas for production, maintaining the shore-based production, sustainable feed-access, political will for upscaling, improved reputation of the industry, increase in demand, positive price development of Norwegian salmon and creation of job opportunities.

The critical issue that emerge from this scenario is the importance of the industry managing to comply with all the key decision factors to ensure a positive development of the industry. To do this, solving the issue of salmon-lice is most important. Therefore, the case that deserve to be addressed by specific contingency plans is the environmental issues, where salmon-lice receive the highest priority. Further, since the development of the industry in Poseidon is dependent on solving the issue of salmon-lice, there should be a high degree of resilience in the industry's strategies to cope with not achieving improvement or experiencing a worsening of the salmon-lice situation.

The factors for monitoring that may disclose whether the industry is developing towards the future state described in the Poseidon scenario are the degree of technology innovation, the efficiency of salmon-lice treatment, the degree of sustainability of the feed-resources, the public view of the industry, the customer's preferences, the demand for Norwegian salmon and the price development of Norwegian salmon.

5.3 Summary of scenarios and action plans

Feil! Fant ikke referansekilden. below present a summary of the scenarios and action plans and Table 11 below present a summary of the parameters for monitoring that may indicate whether the industry is developing towards one of the future states described in the scenarios.

Scenario	Scenario summary	Implication to key decision factors	Validation of original assumptions	Implication for the design and timing of strategies	Threats	Opporunities	Critical issues	Specific contingency plans	Necessary flexibility and resilience	Factors for monitoring
Dry Well	Export volume: 150.000 tonnes. The industry lost control over the salmon-lice situation. This caused the government to introduce new rules and regulations and a stop in development concessions which is inhibiting the growth of the industry. The worsening in the environmental situation further caused the Norwegian salmon to lose its good reputations and thus, the demand for Norwegian salmon has dropped.	Environmental sustainability should receive higher priority than income and economic growth.	Yes, it shows the effect failure to fulfil the aim of the key decision factors may have on the industry.	Create concrete plans of how to handle a worsening in the different force-groups.	Salmon-lice, access to feed-resources, poor fish health, reduction in development concessions, rules and regulations, loss of reputation, shift in customer´s preferences, decrease in demand, loss of market share, negative price development, actors going out of business and higher entry-barriers for new actors.	None.	Ripple effect of a worsening in the situation of the environmental forces on the other forces that affect the industry.	Environmental issues where salmon-lice receive the highest priority.	High flexibility to be able to quickly alter the strategy to account for change. Resilient strategy that include plans of how to handle a worsening of the different force-groups.	Efficiency of salmon-lice treatment, access situation of feed-resources and development of fish health among the cultivated salmon.
Puddle	Export volume: 950.000 tonnes. The industry did not manage to improve the situation of the environmental issues in their production. This caused the public to lose faith in the industry being able to solve these issues and thus, the government has introduced a stop in development concessions. Despite an increase in global demand, the stop in concessions has inhibited the industry from growing and seizing new market shares.	Environmental sustainability should receive higher priority than income and economic growth. Political interests should receive higher priority.	Yes, it shows the effect failure to fulfil the aim of the key decision factors may have on the industry.	Improve the focus on how the forces that affect the industry are connected and the impact they have on each other. Account for the effect of not achieving change within a force-group.	Salmon-lice, poor fish health, access to feed-resources, unsustainable way of production, political resistance, stop in development concessions and new actors seizing market shares.	Achieving exposed aquaculture and increase in global demand for salmon.	Not gaining political will for an upscaling because there are no signs of improvement regarding the environmental issues.	Environmental issues where salmon-lice receive the highest priority and communication of this plan to the public.	Flexible strategy that can be altered quickly to account for change. Resilience for changes within the different force-groups.	Occurrence of salmon-lice, fish health, degree of sustainability of the feed-resources and the public view of the industry.
River	Export volume: 2.110.000 tonnes. The industry has achieved exposed aquaculture and the issue of salmon-lice is eliminated at the exposed locations. The small actors who do not afford to produce offshore are still subject to strict rules and regulations due to the issue of salmon-lice at the production sites near the shore. This is inhibiting the growth of the industry.	Environmental sustainability should receive higher priority than income and economic growth. Political interests should receive higher priority.	Yes, it shows the positive effect of keeping economic growth and marketing a high priority when the global demand is increasing and how not keeping environmental sustainability a high priority may inhibit the growth of the industry.	Continous monitoring of the market situation for efficient marketing. Account for the effect of not solving the environmental issues.	Salmon-lice, high costs of production at exposed locations, strict rules and regulations for companies operating close to the shore and smaller companies struggling to upscale their production.	Achievement of exposed aquaculture, increase in world population, increase in demand for Norwegian salmon, seizing of new market shares, improved reputation of the Norwegian salmon and a positive price development of the Norwegian salmon.	Not gaining political will for an upscaling of the production near the shore and high investment cost to start exposed aquaculture making it difficult for smaller companies to upscale their production.	Environmental issues at the production sites near the shore where salmon-lice receive the highest priority and lowering the cost of starting exposed aquaculture.	Resilient strategy to handle a worsening of the political force-group.	Degree of technology innovation, development of the market situation, customer´s preferences, price development of the Norwegian salmon, occurrence of salmon-lice at production locations near the shore and the public view of the industry.
Poseidon	Export volume: 5.000.000 tonnes. The industry made a choice to solve the environmental issues in collaboration. This proved very successful and through invention of laser technology for salmon-lice-removal, the issue of salmon lice was eliminated. This caused a political will for upscaling and combined with a global increase in demand and good marketing efforts, the industry became the main exporter of salmon in Brazil, Russia, India, China and South Africa.	Environmental sustainability should receive higher priority than income and economic growth.	Yes, it shows the importance of complying with the key decision factors and how doing so is beneficial for the development of the industry.	Account for all the key decision factors and the effect they have on the force-groups.	None.	Collaboration within the industry to solve the environmental issues, achieving exposed aquaculture, consolidation within the industry to cope with high costs of exposed aquaculture, new technology for salmon-lice treatment, new areas for production, maintaining a shore-based production, sustainable feed-access, political will for upscaling of production, improved reputation of the industry, increase in demand, positive price development of Norwegian salmon and creation of job opportunities.	The importance of the industry complying with the key decision factors to ensure a positive growth of the industry. Solving the issue of salmon-lice is especially important.	Environmental issues where salmon-lice receive the highest priority.	Resilient strategy to cope with not achieving change or experience a worsening of the salmon-lice situation.	Degree of technology innovation, efficiency of salmon-lice treatment, degree of sustainability of feed-resources, public view of the industry, customer´s preferences, demand for Norwegian salmon and price development of the Norwegian salmon.

Table 11: Parameters indicating future development

Dry Well	Puddle	River	Poseidon
Worsening in the efficiency of salmon-lice treatment, unsustainable access to feed-resources and worsening of fish health among the cultivated salmon.	Increased occurrence of salmon-lice, low degree of sustainability in feed-resources and a poor public view of the industry.	Increased degree of technology innovation, positive development of the market situation, beneficial development in customer´s preferences, positive price development of the Norwegian salmon, the occurrence of salmon-lice at production locations near the shore and improved public view of the industry.	Increased degree of technology innovation, improved efficiency of salmon-lice treatment, increased degree of sustainability of feed-resources, improved public view of the industry, beneficial development in customer´s preferences, increased demand for Norwegian salmon and a positive price development of the Norwegian salmon.

6 Discussion

This chapter is divided into two sections. The first section present a validation analysis of the scenarios created to ensure that they function as an adequate basis for decision-making. The second section present a discussion of the work performed.

6.1 Validation analysis

The criteria that will be used to validate the scenarios are 1) Plausibility meaning that all the scenarios are plausible to occur, 2) Consistency meaning that there is no inconsistency between the drivers in the scenario, 3) Creativity and coherence meaning that the scenarios are presenting original perspectives and are coherent and 4) Relevance meaning that the scenarios provide insight to the future that is relevant to the industry. To check the scenarios for consistency, a scenario consistency analysis is performed.

Dry Well

Plausibility: In Dry Well, the industry experience a worsening in the situation of all the force-groups that affect the industry where the environmental forces are the main driver. It may be argued that this is an unlikely development for the industry as it is not very plausible that all that can go bad does so at once. However, since the industry in the Dry Well scenario lost control over the salmon-lice situation and did not have any other suited areas for production than along the shore, it is argued in this thesis that the Dry Well scenario is plausible to occur. Further, the industry experience a stop in development concessions. This is argued to be plausible as stated in Chapter 4.1.2, the industry has experienced such a stop in the past.

Consistency: As can be seen in the consistency analysis of Dry Well in Figure 27 below, none of the scenario drivers are considered inconsistent. Therefore, the scenario is considered to fulfil the criteria of consistency.

	C1	C2	C3	C4	C5	C6	C7	C8
C1								
C2	3							
C3	5	4						
C4	5	4	5					
C5	4	3	4	4				
C6	4	3	4	4	4			
C7	4	3	4	3	4	5		
C8	3	3	3	4	3	3	3	

1 = Totally inconsistent, 2 = Partially inconsistent, 3 = Neutral, 4 = Slight positive impact, 5 = Supporting

Scenario drivers:
C1: Increased amount of salmon-lice
C2: Poor access to feed-resources
C3: Poor fish health
C4: Negative political influence
C5: Shift in customer´s preferences
C6: Drop in demand for Norwegian salmon
C7: Negative price development of Norwegian salom
C8: Low degree of consolidation within the industry

Figure 27: Consistency analysis of Dry Well

Creativity and coherence: The Dry Well scenario present an absolute worst-case scenario of the future development of the industry where the main driver is the industry losing control over the salmon-lice situation. The negative development of the other force-groups is the ripple effect from this. Since the idea of the industry losing control over the salmon-lice situation and that the worsening of the situation of the other force-groups is the ripple effect of this, it is in this thesis argued that the Dry Well scenario is both creative and coherent.

Relevance: Since one of the purposes of scenario planning is to encourage decision-makers to think about future developments that they would not otherwise and that the Dry Well scenario is argued to be plausible, it is also argued to be relevant for the industry. Further, salmon-lice are one of the major issues the industry is facing today and therefore considering a worst-case development where this is the driver of change is in this thesis considered to be relevant.

Puddle

Plausibility: The Puddle scenario describe a future development where the public lost their faith in the industry improving the environmental situation and thus the political will for an upscaling vanished. As it is argued in the cross-impact analysis in Chapter 4.2.5, the environmental force-group has a major impact on the political force-group. Further, as stated in Chapter 4.1.2, the industry has in the past experienced a stop in development concessions as they do in the scenario. Therefore, it is argued in this thesis that the development seen in the Puddle scenario is plausible.

Consistency: In Puddle, none of the scenario drivers are in the consistency analysis considered inconsistent as is seen in Figure 28 below. Therefore, the Puddle scenario is in this thesis considered to fulfil the criteria of consistency.

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1									
C2	5								
C3	3	3							
C4	5	5	5						
C5	4	4	3	4					
C6	5	5	5	5	4				
C7	4	4	4	4	3	3			
C8	3	3	3	3	3	3	5		
C9	5	5	4	4	5	4	3	3	

Scenario drivers:
C1: Unchanged amount of salmon-lice
C2: Unchanged fish health
C3: Not developed more sustainable feed-resources
C4: Not achieved a more environmentally sustainable production
C5: Unsuccessful technology innovation
C6: Negative political influence
C7: Unchanged demand for Norwegian salmon
C8: Unchanged price development for Norwegian salmon
C9 Not gained new area for production

1 = Totally inconsistent, 2 = Partially inconsistent, 3 = Neutral, 4 = Slight positive impact, 5 = Supporting

Figure 28: Consistency analysis of Puddle

Creativity and coherence: Since the Puddle scenario describe a future where not achieving change within one force-group is the cause of a worsening of another force-group, it can be argued that the scenario is creative. In Puddle, the industry experience a worsening of the political force-group due to the lack of change within the environmental force-group. This causes a stop in development concessions and thus a stagnation in export levels despite an increase in demand. Since the environmental force-group is in the cross-impact analysis in Chapter 4.2.5 argued to be of high impact on the political force-group, the scenario is argued to be coherent.

Relevance: The Puddle scenario is argued to be relevant for the industry as the scenario describe how not achieving change within one force-group may be the cause of a worsening within another and the scenario describe how such a worsening may affect the development of the industry.

River

Plausibility: The River scenario describe a future where the industry has managed to start offshore production. At the exposed locations, the issue of salmon-lice has been eliminated and the industry can upscale their production. This combined with the increase in demand has enabled the industry to increase

their export. However, since offshore production is expensive, only the larger companies can do this. The smaller companies are still producing near the shore and are still subject to strict rules and regulations that inhibit them from upscaling their production. Therefore, the industry has not reached their export goal for 2050. In this thesis, this is considered a plausible scenario.

Consistency: As can be seen in the consistency analysis in Figure 29 below, none of the scenario drivers are considered inconsistent in River. Therefore, the scenario is considered in this thesis to fulfil the criteria of consistency.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1										
C2	5									
C3	5	5								
C4	3	3	3							
C5	5	3	3	3						
C6	5	4	5	3	3					
C7	3	3	3	5	3	3				
C8	3	3	4	3	3	4	3			
C9	3	3	4	3	3	3	3	5		
C10	3	3	4	3	3	4	3	5	5	

1 = Totally incosistent, 2 = Partially inconsistent, 3 = Neutral, 4 = Slight positive impact, 5 = Supporting

Scenario drivers:
C1: Successful technology development
C2: New areas for production
C3: Salmon lice eliminated at exposed locations
C4: Unchanged salmon-lice situation at production sites near the shore
C5: Increased degree of consolidation within the industry
C6: Positive political influence for exposed production
C7: Negative political influence at production sites neat the shore
C8: Increased demand for Norwegian salmon
C9: Positive development in customer´s preferences
C10: Positive price development of Norwegian salmon

Figure 29: Consistency analysis of River

Creativity and coherence: The River scenario is in this thesis argued to be creative as it describes a situation where exposed aquaculture is achieved and salmon-lice at the exposed locations are eliminated. However, due to the high investment costs it is too expensive for smaller companies to start offshore production. Thus, the industry does not achieve their 2050-goals despite the success of exposed aquaculture. The scenario is also argued to be coherent as the industry seize opportunities from the increase in demand due to the success of exposed aquaculture.

Relevance: The River scenario is in this thesis argued to be of relevance for the industry as it shows how eliminating the environmental issues and how the degree of consolidation within the industry may affect the future development. With more consolidation, the industry might have achieved a higher export volume in this scenario.

Poseidon

Plausibility: The Poseidon scenario show the future development in 2050 that is in this thesis considered the best-case development. In Poseidon, the industry reach all their 2050-goals as they manage solve the environmental issues through collaboration. The improvement in the environmental force-group cause an improvement in the political force-group creating a political will for upscaling. The upscaling of the industry proves successful as the growth in world population create an increase in demand. Since the environmental force-group is in the cross-impact analysis in Chapter 4.2.5 argued to be of high impact on the political force-group and the growth in world population is predicted to cause an increase in demand, the Poseidon scenario is in this thesis considered plausible. However, the future development seen in Poseidon require the industry to successfully comply with all the key decision factors identified in Chapter 4.2.2.

Consistency: As is seen in Figure 30 below, none of the scenario drivers in the Poseidon scenario are in the consistency analysis considered to be inconsistent. Therefore, the scenario is in this thesis considered to fulfil the criteria of consistency.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
C1											
C2	4										
C3	4	5									
C4	3	4	5								
C5	4	5	5	3							
C6	4	3	3	3	3						
C7	4	4	5	5	4	5					
C8	4	4	5	5	4	5	5				
C9	3	3	4	4	3	4	5	4			
C10	3	3	4	4	3	4	4	3	5		
C11	3	3	4	4	3	4	5	3	5	5	

1 = Totally incosistent, 2 = Partially inconsistent, 3 = Neutral, 4 = Slight positive impact, 5 = Supporting

Scenario drivers:
C1: Increased degree of consolidation within the industry
C2: Successful technology development
C3: Improved salmon-lice situation
C4: Improved fish health
C5: Sufficient area for production
C6: More sustainable feed-resources
C7: More environmentally sustainable production
C8: Positive political influence
C9: Positive development in customer´s preferences
C10: Increased demand for Norwegian salmon
C11: Positive price development of Norwegian salmon

Figure 30: Consistency analysis of Poseidon

Creativity and coherence: The Poseidon scenario is in this thesis argued to be creative as it shows a development where the industry benefit from collaborating to solve the environmental issues. The scenario is also argued to be coherent as the achievement of the 2050-goals in the scenario is the result of solving the environmental issues which caused an improved political will for upscaling. As argued in the cross-impact analysis in Chapter 4.2.5, the environmental force-group is of high influence on the political force-group. Further, the industry experienced an improvement of the market force-group and due to the green light to upscale their production they managed to seize opportunities.

Relevance: The Poseidon scenario is in this thesis considered to be relevant for the industry as it shows the importance of complying with the key decision factors identified in Chapter 4.2.2. Further, it shows that the 2050-goals are reachable if the industry manage to solve the environmental issues it is facing which might be a prerequisite to achieve these goals.

6.2 Discussion of the work performed

The results of this thesis work are a set of scenarios of how the future may look like for the Norwegian aquaculture in 2050 and a set of corresponding action plans. The action plans presented contain proposals of how the decision-makers in the present can steer the development of the industry towards the different future states of the scenarios.

To perform the analysis in this thesis, six interviews with seven relevant stakeholders of the industry has been used as input. To decide who to contact for an interview, a stakeholder-map was created as seen in Appendix A.1 Stakeholder-map. From this stakeholder-map, a selection of stakeholders was made where creating a diverse composition of stakeholders from different stakeholder-groups was a priority. The interviews have provided the analysis with valuable insight and have been essential for the creation of the scenarios and action plans. However, using interviews with selected stakeholders of the industry may make the results somewhat limited. The reason for this is that the output of the analysis is very dependent on who is providing the input. If the selection of stakeholders was different, it is very likely that the results of the analysis would be so too. Therefore, attempting to get a high degree of diversity among the stakeholders should be kept a high priority as the different stakeholders all have different incentives.

Further, the choice of method will also affect the results of the scenario analysis. There are many different methods for scenario planning and it can be argued what method is best to use. As stated in the literature review in Chapter 3.3, qualitative approaches are argued to be best suited when the time

horizon is long. Among the qualitative approaches, the SRI approach proposed by Stanford Research Institute is most commonly used and this is the method that is used in this thesis. If another method was selected, the results of the analysis might have been different (Amer et al., 2012).

While performing the analysis it has become evident that there are several steps in the analysis where it would have been beneficial to perform the steps in collaboration with the stakeholders. This especially applies to the cross-impact analysis where the impact the different force-groups have on each other is analysed and the morphological analysis where the scenario themes that are interesting to elaborate are selected in Chapter 4.2.5. Creating the action plans in collaboration with the stakeholders would also be beneficial. The reason for this is that those who have been interviewed have been selected because they are considered experienced actors within the industry. Therefore, it can be argued that the quality of the scenarios and action plans would have been higher if they had been included in the performing of the analysis and thus taking more advantage of this experience. The action plans would especially benefit from being created in collaboration with members who have worked within the industry and who are familiar with their current strategies.

Another issue with the action plans is that since the industry consist of several actors within different sectors who all have their own agendas, it is difficult to create action plans for the industry as one unit. Therefore, it can be argued that the action plans serve more as a general indication of what issues the different actors should keep in mind when making decisions and that for the action plans to be of more direct use, each actor should create their own action plans on a company-level based on the information presented in the scenarios.

The quality of the scenarios created have been assessed by performing a validation analysis based on the four criteria for scenario validation that was most frequently identified in the literature review in Chapter 3.4. These criteria were 1) Plausibility, 2) Consistency, 3) Creativity and coherence and 4) Relevance. As can be seen in the validation analysis presented in Section 6.1, all the scenarios created fulfil all the criterions and should therefore all function as an adequate basis for decision-making. However, as stated in Chapter 3.4 in the literature review, Peterson et al. argue that to check the scenarios for consistency, the stakeholders should be involved in the process. This is to ensure that the behaviour of the actors involved in the scenarios is plausible. Further, the criterion of relevance to the industry meaning whether the scenarios provide insight to the future that will help decision-making is an assessment that should be determined by members of the industry. Therefore, it is difficult to determine the quality of the scenarios by relying on the validation analysis performed in this thesis (Peterson et al., 2003).

Further, as stated in the literature review in Chapter 3.1, Schwartz argue that the scenarios should continuously be reviewed and edited as new knowledge becomes available. Therefore, the results of this thesis may be valid today, but if they are to serve as a decision-making aid towards 2050 they must be reviewed as the input parameters change (Wright, 2000, Schwartz, 1997).

As stated in Chapter 3.5, it is argued in the literature that there are both advantages and disadvantages of using scenario planning. The advantages most frequently mentioned in the literature is the ability to stimulate decision-makers to consider developments they would not otherwise, aid decision-makers to avoid threats and seize opportunities in the future as scenario planning enhance the participant's ability to effectively respond to a wide range of possible future developments, aid organizations to test their strategies and enable organizational learning. To what extent the industry experience these advantages

and thus, the effectiveness of performing such a scenario planning analysis is difficult to determine (Shoemaker, 1995, Chermack et al., 2001, Georgantzas and Acar, 1995, Heijden, 1996).

Further, there are identified several pitfalls of using scenario planning which are presented in Chapter 3.5. The most common pitfalls are the perennial call for top management support, failure to stimulate new strategic options, not seeing the scenario planning process as an integrated process with other organizational decision making processes, balancing immediate concerns of management on short-term results with long-term focus areas and confronting managers with scenarios in such a way that they get defensive and reject them. Further, as stated in the literature review, the scenarios need to balance what the future might bring with what the organizations are ready to contemplate. If the industry is to rely on scenario planning as part of their long-term strategy, they must be aware of these pitfalls (Wright, 2000, Fahey, 1998).

It is difficult to find other scenario planning analyses for the Norwegian aquaculture industry that use the SRI approach to compare this thesis work with. The Norwegian Research Council initiated in 2004 a project where the outcome was a foresight analysis of the development of the Norwegian aquaculture industry towards year 2020 named "Aquaculture 2020 Pioneering – if…". For this foresight analysis seventy people from different research societies, the government and members from the industry were involved and the aim of the project was to create several mini-scenarios and five more complex scenarios. The five complex scenarios all described different possible futures where the change-drivers were value creation/production/new species, transport and logistics, e-business, competition, alliances, the knowledge-regime/knowledge-infrastructure, the placement of knowledge, consumer demand, production demand, access to export markets, emergence of new markets, product innovation, process innovation, feed, bio-technology, ethics/animal welfare and climate and environment. The scenarios created in the foresight analysis were used to generate strategic recommendations and actions aimed at the research society, the government and the industry (Giskeødegård et al., 2004).

The number of stakeholders involved in the scenario planning process may also affect the quality of the results. In this thesis work, only seven stakeholders were involved. In comparison with the foresight analysis performed by the Norwegian Research Council were seventy stakeholders were involved, this number is very low. Thus, it is likely that the quality of the results in the foresight analysis is higher than this scenario planning analysis. The reason for this is that by including more stakeholders, the likelihood of covering a broader set of different perspectives is higher. As seen in the stakeholder-map in Appendix A.1 Stakeholder-map, there was in this thesis identified ten different main groups of stakeholders. By interviewing seven members it is not possible to cover all these groups.

The benefit of the information provided in this thesis can be argued to be that the scenarios may encourage those presented to them to consider possible future developments they would not have otherwise. Further, the thesis work might make those presented to it see the potential of implementing scenario planning as a part of their long-term strategy within their own company. Since the world population and the buying power in countries considered of high potential to the Norwegian aquaculture industry is increasing, the industry will face threats and opportunities in the future. To handle these threats and to take advantage of the opportunities, implementing scenario planning might be a viable option.

7 Conclusion

The objective of this thesis was to create a set of scenarios and corresponding action plans for the Norwegian aquaculture industry towards 2050. The aim of doing this was to encourage decision-makers to consider possible futures that they would not otherwise and to serve as an aid towards achieving the 2050-goals of the industry.

After conducting the scenario planning analysis in this thesis, it has become evident that there are several factors that may influence the quality of the results. Firstly, the choice of stakeholders to involve in the process, the number of involved stakeholders and the diversity among them will affect the results as stakeholders from different parts of the industry will have different incentives. Secondly, the choice of scenario planning method will affect the results of the analysis. Therefore, when choosing what method to use it is important to consider the planning time horizon as quantitative methods are better suited for short time horizons and vice versa. Thirdly, it has become clear that involving the stakeholders during the whole process and not just use them as input may be beneficial for the results. The reason for this is because there are several parts of the analysis where drawing advantage from the knowledge and insight of experienced stakeholders would increase the quality of the work. This especially applies for the part where the action plans are created. Further, it has become evident that to create concrete action plans for an industry as one unit is difficult and therefore, the action plans created serve as an identification of the important issues for the decision-makers within the industry to consider when making decisions. Lastly, since the world is in continuous change, the scenarios created should be continuously reviewed as the input parameters change if they are going to serve as a decision-making aid towards 2050.

However, this thesis does fulfil its objective as the scenarios created all describe possible future developments which may encourage the decision-makers presented to them to consider developments they would not have otherwise. Further, since there are many advantages associated with implementing scenario planning as a part of a company's long-term strategy, doing so may enable the companies to better seize opportunities and avoid threats in the future given that they are aware of the pitfalls of using scenario planning. Therefore, since the scenarios and action plans may cause the stakeholders presented to them to see the value of implementing scenario planning, the thesis fulfils the aim of serving as an aid towards achieving the 2050-goals.

The conclusion of this thesis is therefore that the scenarios and action plans created do fulfil the objective of the thesis, but for the actors within the industry to have more use of a scenario planning analysis they should implement it as part of their own company's long-term strategy.

8 Further work

It became evident during this thesis that several of the steps in the analysis would benefit from involving the stakeholders in the process. Therefore, performing the whole analysis in collaboration with the stakeholders would be of interest for continuing of the work performed. By doing so, it is likely that the quality of the scenarios and the action plans would be higher.

For individual companies to benefit more from the information provided in this thesis, performing the analysis themselves within their own company and implementing scenario planning as a part of their long-term strategy would be a natural continuing of this thesis work. When doing so, the work performed in this thesis may serve as a guideline of how to perform a scenario planning analysis.

Within the field of scenario planning, an area that should be furthered researched is the effectiveness of scenarios. As stated in the literature review in Chapter 3.4, only one study of the effectiveness of scenarios performed by Shoemaker in 1995 was found in the literature. Therefore, presenting decision-makers within the industry with this thesis work and researching the effectiveness of doing so may be of interest for further work. This could be done as Shoemaker did it, by studying how presenting the decision-makers with the scenarios change their perception of the future development (Shoemaker, 1995, Chermack et al., 2001).

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Appendix

A.1 Stakeholder-map

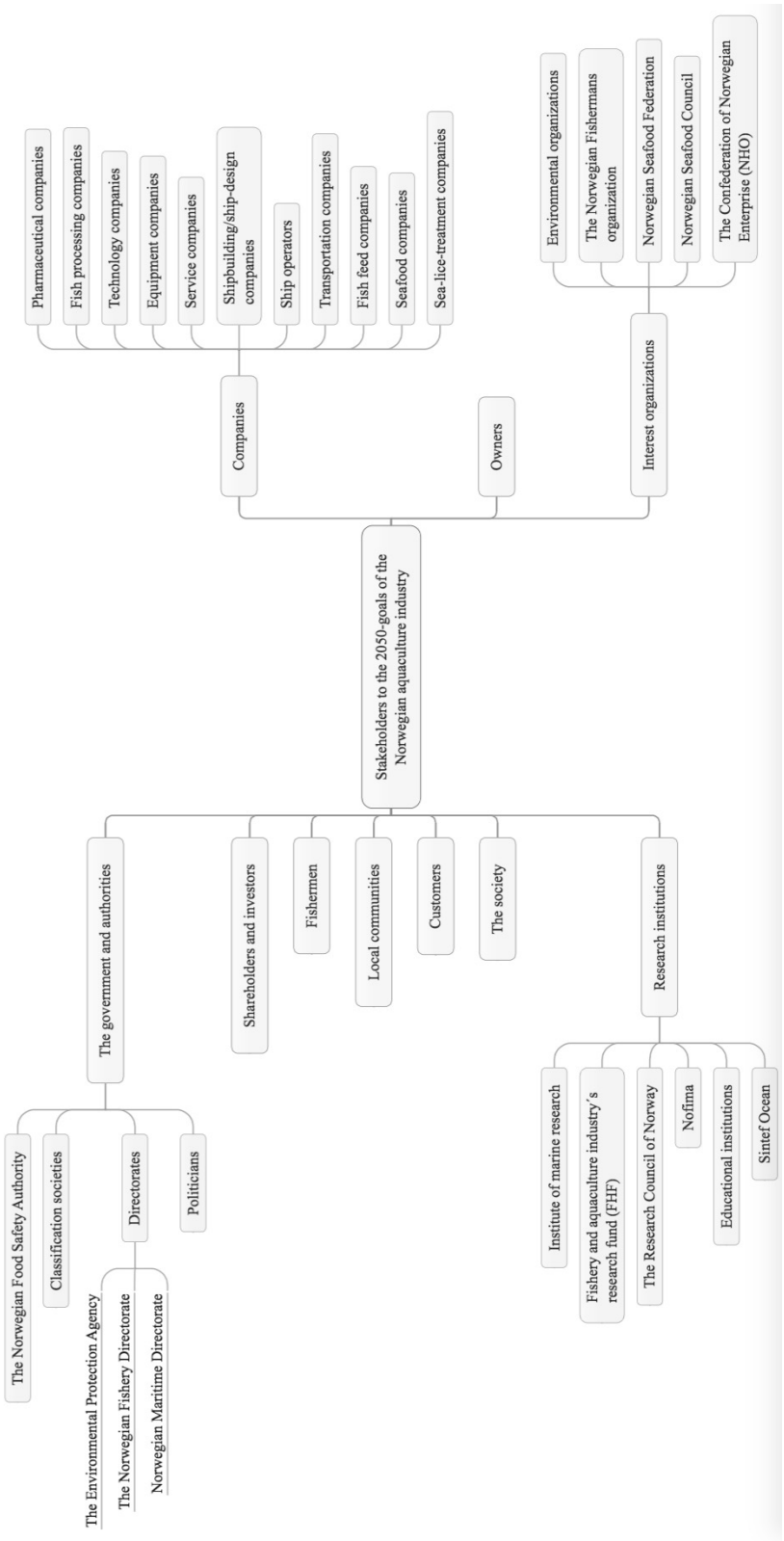


Figure 31: Stakeholder map

A.2 Interview questions

Intervjuspørsmål

1. Har du noen innvendinger til målene som er identifisert nedenfor under" Mål for 2050"?
2. Hva mener du er de viktigste forutsetningene for at industrien skal nå de målene den har satt seg for år 2050?
3. Hva anser du som de største truslene for at industrien skal nå disse målene?
4. Når avgjørelser skal tas i industrien, hva mener du er de viktigste faktorene å ta hensyn til?
5. Hvilke faktorer påvirker utfallet av avgjørelser som tas i industrien mest i dine øyne?
6. Hvilke krefter tror du vil kunne ha påvirkning på industrien sin utvikling?
7. Vil du rangere usikkerheten knyttet til hver av disse kreftene som høy, medium eller lav?
8. Vil du rangere påvirkningskraften på industrien til hver av disse kreftene som høy, medium eller lav?
9. Hva anser du som flaskehalsene i industrien dersom den skal oppnå målet om økt produksjonsmengde?
10. Er det noen områder i industrien hvor du mener at endring er nødvendig for å oppnå målene som er satt for 2050?
11. Hvordan ser det beste, det verste og det mest sannsynlige scenarioet for industrien i år 2050 ut i dine øyne?
12. I et scenario hvor industrien ikke oppnår 2050-målene og bare produserer 2 millioner tonn laks i 2050, hva tror du årsaken til denne utviklingen kan være?

Mål for 2050:

- Øke produksjonen av laks til 5 millioner tonn.
- Oppnå en bærekraftig utvikling ved å:
    - Redusere antall rømninger
    - Redusere skadevirkningen fra lakselus
    - Bedre fiskehelsen til oppdrettsfisken
    - Sikre god tilgang til og utnytting av forressurser
    - Øke utnytting av avfall fra fiskeoppdrett
    - Oppnå effektiv areal-utnyttelse
    - Redusere utslipp fra fiskeoppdrett
- Å fortsette å være en skaper av arbeidsplasser

Interview questions translated:

Interview questions

1. Do you have any objections to the goals identified below under "Goals for year 2050"?
2. What do you think are the most important prerequisites for the industry to achieve these goals?
3. What do you consider the threats for the industry if they are to reach these goals?
4. When decisions within the industry are made, what do you consider the most important factors to consider?
5. What factors affect the outcome of decisions made within the industry in your eyes?
6. What forces do you believe may affect the development of the industry?
7. Would you rank the uncertainty of each of these forces as high, medium or low?
8. Would you range the impact on the industry of each of these forces as high, medium or low?
9. What do you consider the bottlenecks within the industry if it is to reach its goal of increase in production levels?
10. Are there any areas within the industry where you think change is necessary to reach the goals for year 2050?
11. In your eyes, what is the best, worst and most likely scenario for the industry in year 2050?
12. In a scenario where the industry does not reach its 2050-goals and only produce 2 million tonnes salmon in 2050, what do you believe the cause of this development is?

Goals for year 2050:

- Increase the production of salmon to reach 5 million tonnes.
- Achieve a sustainable production by:
    - Reduce the number of escapes.
    - Reduce the damaging impact of salmon-lice.
    - Improve the fish health of the cultivated salmon.
    - Secure good access to and exploitation of feed resources.
    - Increase the exploitation of waste from aquaculture.
    - Achieve efficient area-usage.
    - Reduce the emissions from aquaculture.
- Continue to be a creator of job opportunities.

A.3 Average approach to ranking of key environmental forces

Table 12 below present the identification results of the key environmental forces gained from the interviews. To evaluate the importance of each force it is possible to use an average approach by using Formula 2 presented below where L=1, M=2 and H=3. The resulting force rankings are presented in Table 13 below.

The issue of using this approach is that a high identification frequency among the stakeholders is not considered a reason to increase the priority of a force. Instead, a high identification frequency may lower the resulting priority ranking. Another issue is that forces identified by few stakeholders are considered as important as forces identified by many. These two issues are visible if force 1) Salmon-lice and force 6) Customers preference are compared. Salmon-lice was identified by three stakeholders and received the following rankings for uncertainty and impact on the industry respectively; MM, HH, MH while customer's preference was only identified as a force by one of the stakeholders and received the ranking HH. By using the average approach customer's preference receives a ranking of 3 for both uncertainty and impact on the industry, whilst salmon-lice receive the ranking 2,3 and 2,7 respectively. Therefore, salmon-lice are considered a lower priority than customers preference even though salmon-lice was identified by three stakeholders and received the same ranking as customer's preference by one of the three stakeholders who identified it as a force.

Table 12: Identification of key environmental forces

Force id.	Forces identified	Number of times identified	Ratings of uncertainty	Ratings of impact on the industry
1	Salmon-lice	3	M, H, M	M, H, H
2	Demand	2	L, M	M, H
3	Political influence	2	H, M	H, M
4	Price development of Norwegian salmon	2	H, L	L, M
5	Environmental sustainability	2	H, H	H, H
6	Customer preferences	1	H	H
7	Fish health	1	L	H
8	Area for production	1	H	H
9	Technology innovation	1	H	H
10	Ability of the actors to communicate	1	H	H
11	Consolidation within the industry	1	H	M
12	Access to feed-resources	1	H	H

L: Low, M: Medium, H: High

Formula 2: Average approach key environmental force priority ranking

$$Average\ rating = \frac{\Sigma Individual\ ratings}{Number\ of\ times\ the\ force\ has\ been\ identified}$$

Table 13: Rating of key environmental forces using an average approach

Force id.	Forces identified	Average rating of uncertainty	Average rating of impact on the industry
1	Salmon-lice	2,3	2,7
2	Demand	1,5	2,5
3	Political forces	2,5	2,5
4	Price development of Norwegian salmon	2	1,5
5	Environmental forces	3	3
6	Customers requirement of an environmentally sustainable production	3	3
7	Fish health	1	3
8	Area for production	3	3
9	Technology innovation	3	3
10	Ability of the actors to communicate	3	3
11	Consolidation within the industry	3	2
12	Access to sufficient feed-resources	3	3

A.4 Pre-project report

NTNU Trondheim
Norwegian University of Science and Technology
Department of Marine Technology

PRE-PROJECT REPORT

MASTER THESIS IN MARINE TECHNOLOGY

For stud.techn.

Norwegian Aquaculture 2050:

A Scenario Planning Analysis

William Finne

Background

The only certainty about the future is that it is uncertain. Traditional forecasting methods typically work under the assumption that the future is dependent on what has happened in the past. This assumption may prove to be accurate for a short time horizon, but when the time horizon is expanded these methods often prove inaccurate. Further, traditional forecasting methods typically don't account for unforeseen events. When the time horizon is expanded, the probability of unforeseen events occurring increase as well. This is where scenario planning differs from traditional forecasting methods. Scenario planning is a method of preparing for the future where several plausible future scenarios are created. By doing this, the method can capture a wide range of possible future outcomes and thus stimulate decision makers to consider developments they would not otherwise. Imagining these developments may make the decision makers better prepared to handle uncertainty and unforeseen events. (Finne, 2016, Shoemaker, 1995).

With an increasing world population, producing sufficient amounts of healthy food is a global challenge. It is estimated by the UN that within 2050 the world population will have reached 9,7 billion people and it is projected by the World Bank that by 2030, 62% of all consumed seafood will be farm raised. The increasing demand for food resulting from the world population growth poses a big opportunity for the Norwegian aquaculture industry to increase their export (UN, 2015, Bjelland et al., 2015, TheWorldBank, 2013).

Since its beginning in the 1970s, the Norwegian aquaculture industry has experienced a major growth in their production and in 2016, the value of exported products from the industry exceeded a value of 65 billion NOK. The industry has a goal that within 2050 the production volume of the industry shall reach a value of 5 million tonnes. This represent a 5-times increase in production volumes. For the industry achieve this goal they must have a strategy of how to seize opportunities and avoid threats that may occur in the future. Since the time horizon for the goals of the industry is long, implementing scenario planning may prove to be a good strategy as an aid to achieve these goals (Furuset, 2017, Olafsen et al., 2012, NSC, 2017c).

Objective

The objective of this thesis is to create a set of scenarios of how the industry may develop towards 2050 and a set of corresponding action plans that considered may encourage decision makers to consider possible futures that they would not have otherwise and that may serve as an aid towards achieving the industry's 2050-goals.

Tasks

1. Perform a literature review on:
    a. The definition of scenario planning.
    b. The development of scenario planning
    c. Scenario planning methodologies
    d. Validation and effectiveness of scenario planning
    e. The advantages and disadvantages of using scenario planning.
2. Perform a literature search on the current situation of the Norwegian aquaculture industry.
3. Perform a literature search on the past development of the Norwegian aquaculture industry.
4. Perform a literature search on the value chain of the Norwegian aquaculture industry.
5. Perform a literature search on the 2050-goals of the industry.
6. Perform a literature search on the prerequisites for the industry to reach the 2050-goals.
7. Perform a PESTEL-analysis of the Norwegian aquaculture industry.
8. Perform a competitive force analysis of the Norwegian aquaculture industry.
9. Perform a SWOT-analysis of the Norwegian aquaculture industry.
10. Create a stakeholder-map of relevant stakeholders of the Norwegian aquaculture industry.
11. Create a list of questions for the interviews with the relevant stakeholders.
12. Conduct interviews with stakeholders of the industry. These are:
    a. Snorre Jonassen, Director at Cermaq.
    b. Trude Olafsen, Project manager at Aquagroup.
    c. Jens Christian Holm, Director at the Coast- and aquaculture department at the Norwegian Fishery Directorate.
    d. Thor Hukkelås, Head of aquaculture-products at Kongsberg Maritime.
    e. Rune Magne Nilsen, Senior Surveyor at the cargo ship department at the Norwegian Maritime Directorate.
    f. Åse Waage, Deputy Director, Subdivision removable devices at the Norwegian Maritime Directorate.
    g. Karl Andreas Almås, Special advicer at Sintef Ocean.
13. Perform a scenario planning analysis of the Norwegian aquaculture industry using the SRI approach.
14. Perform a validation analysis of the scenarios created in the scenario planning analysis.

Plan and structure

The first part of the thesis will be a literature review on the existing literature on scenario planning. The focus areas will be literature on what scenario planning is, how it has developed, the different approaches, validation of scenarios and advantages and disadvantages of using scenario planning.

The next part of the thesis will give a description of the current situation the Norwegian aquaculture industry as well as a description of the development the industry has experienced in the past. Next, the thesis will give a description of the industry's value chain for salmon production and identify the bottlenecks that are critical when upscaling the production. Further, the goals of the industry towards 2050 will be identified as well as prerequisites to achieve these goals. Next, a PESTEL-analysis, a competitive force analysis and a SWOT-analysis will be performed.

Next, a scenario planning analysis of the industry will be performed using the insight gained from the interviews as a basis. The last part of the thesis will be a validation analysis of the scenarios created to ensure that they all serve as an adequate basis for decision-making.

Methodologies

The research in this thesis will be mainly qualitative. The qualitative data used in the scenario planning analysis will be gathered through literature search, literature reviews and interviews with members from the Norwegian aquaculture industry. In addition, a PESTEL-analysis, a competitive force analysis and a SWOT-analysis will be performed.

The scenario planning analysis will be performed using the SRI scenario planning approach. Within this approach, a cross-impact analysis and a morphological analysis will be performed.

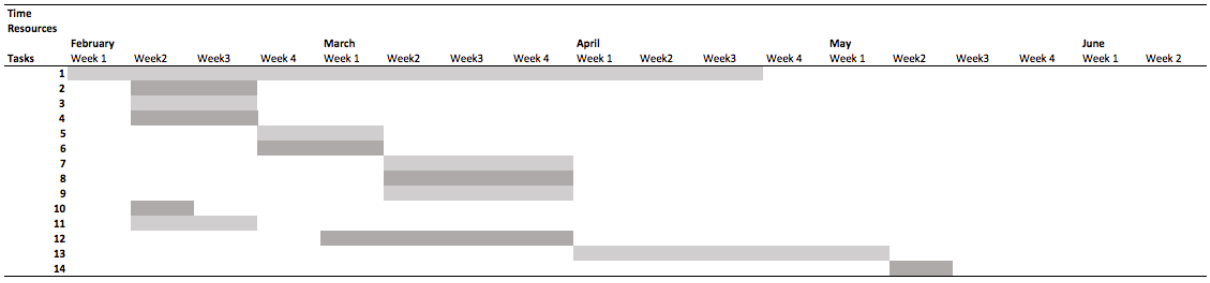
After the scenario planning analysis has been performed, a validation analysis of the scenarios created will be performed. To check the scenarios for consistency, a consistency analysis will be performed.

Directions and aims

The aim for this thesis is to create a set of scenarios and corresponding action plans in collaboration with Sintef SFI Exposed and other stakeholders within the industry which may aid the industry to achieve the desired growth of the industry.

Time resources

The table below illustrate the time resource plan for this master thesis work. The grey areas illustrate in what time periods the different tasks listed in this report should be performed.



Outputs envisaged

The output of this thesis work will be a set of scenarios and corresponding action plans that may be beneficial for the Norwegian aquaculture to seize opportunities and avoid threats towards 2050. The scenarios will describe different possible future developments and the action plans will contain actions aimed at achieving the goals of the industry in the different scenarios.

General

In the thesis, the candidate shall present his personal contribution to the resolution of a problem within the scope of the thesis work.

Theories and conclusions should be based on a relevant methodological foundation that through mathematical derivations and/or logical reasoning identify the various steps in the deduction.

The candidate should utilize the existing possibilities for obtaining relevant literature.

The thesis should be organized in a rational manner to give a clear statement of assumptions, data, results, assessments, and conclusions. The text should be brief and to the point, with a clear language. Telegraphic language should be avoided.

The thesis shall contain the following elements: A text defining the scope, preface, list of contents, summary, main body of thesis, conclusions with recommendations for further work, list of symbols and acronyms, reference and (optional) appendices. All figures, tables and equations shall be numerated.

The supervisor may require that the candidate, in an early stage of the work, present a written plan for the completion of the work.
The original contribution of the candidate and material taken from other sources shall be clearly defined. Work from other sources shall be properly referenced using an acknowledged referencing system.

Deliverable

- The thesis shall be submitted in two (2) copies:
- Signed by the candidate
- The text defining the scope included
- In bound volume(s)
- Drawings and/or computer prints that cannot be bound should be organized in a separate folder.
- The bound volume shall be accompanied by a CD or DVD containing the written thesis in Word or PDF format. In case computer programs, have been made as part of the thesis work, the source code shall be included. In case of experimental work, the experimental results shall be included in a suitable electronic format.

Supervision

Main supervisor: Bjørn Egil Asbjørnslett, NTNU

Sub-supervisor: Hans Bjelland, Sintef, Sintef Ocean, SFI Exposed

Deadline: 11.06.2017