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– A case study on aqua-agro interactions in food production on Åland

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Exploring business model innovation for circular bio-economy – A case study on aqua-agro interactions in food production on Åland

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Ludvig Bennetoft & Natalie Tysk

Abstract

Because of the growing population in the world, leading to increased resource demand and at the same time the need for conserving the environment, there is a growing interest in transitioning from present economic systems to a more sustainable future. Out of this context, the concept circular bio-economy (CBE) is highlighted by policy makers and governments, and adopted by businesses, because it is as a way of decreasing human-induced environmental impacts, generate new market opportunities and use resources more efficiently. The CBE concept aims to replace the fossil-based resources with bio-based resources and change the current linear economies to circular ones. One example of CBE development is the interaction between aquaculture and agriculture, framed as aqua-agro interactions, which is promoted as one way of increasing food production, conserving the environment and ensure food security by taking care of the side-streams and the wasted nutrient flows from each other's sectors.

On Åland, which is an island in the Baltic Sea and a part of Finland, they have both aquaculture and agriculture food production. They also have a newly developed regional food strategy, where the aim is to develop a more sustainable and circular food production. Instead of working from individual circular systems, the suggestion is to implement bio-circular business models where actors on Åland can find circular solutions and together contribute to a more sustainable food system. To succeed with this transformation the farmers will need to change their current business models commonly refers to as "business as usual". To move away from "business as usual" models and develop new ones that accord with ideas of CBE, firms in particular, has to develop new business models. There is thus a need for research that focuses on sustainable business models innovation that will help the firms realise the opportunities and adoption this new way of thinking. Therefore, this study investigates and critically assesses the criteria for sustainable business model innovation (SBMI) to assist development for CBE with a particular focus on aqua-agro interactions on Åland.

An exploratory case study was conducted. Data were collected through semi-structured interviews with eight actors on Åland having a relation to aquaculture and agriculture sectors. The data were analysed through the conceptual framework developed in this study and consisting of analytical labels received from the literature review. The literature review reveal that the concept of cascading bio-based resources and closing resource loops are appropriate concepts to promote business model innovation for CBE development. Further, relevant criteria to facilitate business model innovation in line with these concepts include combination of collaboration, policy and regulation that support innovations, a willingness from the society, and last the need for more research and innovation. The criteria were strengthen by the result of the case study. Findings from exploratory case study research show that in order to develop CBE business models with emphasis on aqua-agro interactions it requires a consensus between the actors that shape the developments in relation to the criteria. Further contribution of this study, is that there is a need to not just innovate business models. Because of the existing system constraints there is also a need for system innovation.

Sammanfattning

Det finns ett växande intresse för att förändra det nuvarande ekonomiska systemet till ett mer hållbart sådant. Det beror på den nuvarande växande befolkningen i världen som i sin tur leder till ett ökat resursbehov. Samtidigt finns det ett ökande behov av att bevara vår miljö. Utifrån detta sammanhang framhävs konceptet cirkulär bio-ekonomi av beslutsfattare och regeringar samt uppmärksammas även av näringslivet. Det är ett koncept som spås kunna minska miljöpåverkan, skapa nya marknadsmöjligheter, samtidigt som resurser används mer effektivt. Konceptet syftar till att ersätta de fossilbaserade resurserna med biobaserade resurser och ändra de nuvarande linjära ekonomierna till cirkulära. Ett exempel på utveckling inom konceptet cirkulär bio-ekonomi, är samspelet mellan vattenbruk och jordbruk, vilket framhävs som en interaktion som kan öka livsmedelsproduktionen, bevara miljön och säkerställa livsmedelssäkerheten genom att ta hand om bi-produkter och avfallsströmmar som annars är bortkastade näringsämnen.

På Åland finns det både vattenbruk och jordbruk och de har också en nyutvecklad regional livsmedelsstrategi som syftar till att utveckla en mer hållbar och cirkulär livsmedelsproduktion på Åland. Istället för att arbeta från enskilda cirkulära system förespråkas ett system där flera aktörer kan hitta cirkulära lösningar och tillsammans bidra till ett mer hållbart livsmedelssystem. För att lyckas i omvandlingen måste aktörerna i livsmedelskedjan förändra nuvarande affärsmodeller för att kunna kommersialisera de nya processerna, de nya produkterna och fånga nya värden i livsmedelskedjan. Därav finns det ett behov att studera innovation av hållbara affärsmodeller som kan hjälpa företagen att realisera möjligheterna och transformera det gamla systemet till detta nya sätt att förhålla sig till livsmedelskedjan. Därför syftar denna studie till att undersöka och kritiskt bedöma kriterierna för innovation av hållbara affärsmodeller, för att hjälpa utvecklingen av konceptet cirkulär bio-ekonomi med särskild inriktning på interaktion mellan vattenbruket och jordbruket på Åland.

En fallstudie med utforskande karaktär har genomförts genom semi-strukturerade intervjuer med åtta aktörer på Åland som har en relation till Ålands vattenbruk och jordbruk. Den insamlade empirin har analyserats med hjälp av studiens konceptuella ramverk som består av kriterier för utveckling av konceptet cirkulär bio-ekonomi och interaktioner mellan vattenbruk och jordbruk som erhölls från den genomförda litteraturgenomgången.
Litteraturgenomgången hävdade att fenomenen ”cascading” av bio-baserade resurser och slutna resursflöden är framträdande i utvecklingen av konceptet cirkulär bio-ekonomi. De relevanta kriterierna för att förnya affärsmodeller i linje med dessa fenomen var en kombination av samarbete, ett rättslitg ramverk som möjliggör innovationer, en vilja från de politiska beslutsfattarna och samhället, samt behovet av mer forskning. Detta stärktes av den insamlade empirin. Ytterligare slutsatser i studien är att för att utveckla affärsmodeller med tonvikt på interaktion mellan vattenbruk och jordbruk krävs det en samsyn mellan de aktörer som formar och utvecklar kriterierna.

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1 Introduction

The following chapter presents the background of the study and the problem addressed. Further, the aim, the research questions and delimitations of the study, and last, the outline of this thesis is presented and illustrated.

1.1 Problem background

Today's economy is based on a linear model, described as “take-produce-consume-discard process” with the focus to produce as cheaply as possible (EMF, 2015; Jurgilevich et al., 2016; WEF, 2014). The description implies that usage of raw materials to produce goods are later sold, used and then discarded as waste. The results are losses of energy and natural resources with the content of bearing the cost of throwing non-renewable resources away (EMF, 2015; Jurgilevich et al., 2016). This linear economic system is referred to as unsustainable (Godfray et al., 2010). At the same time global population continues to grow which leads to higher demand for resources (Godfray et al., 2010; www, Naturvårdsverket, 2017; OECD/FAO, 2013; WEF, 2014). Therefore, there is a growing interest in transitions from linear economic systems, which comprise phases of resource extraction, manufacturing, use, and disposal, to circular ones, which are based on a restorative and regenerative use of resources (Ghisellini et al., 2016; EMF, 2015; Ness, 2008). This circular economic system is referred to as more sustainable (Godfray et al., 2010).

Out of the perspective of the great triple challenge, that is to produce more food for a continually growing population to ensure food security and at the same time conserve the environment, states the need for developing sustainable food production systems (Godfray et al. 2010). The aquaculture and agriculture sectors are the centrepiece of current food production systems in the world. Aquaculture is the production of fish, shellfish, mussels and aquatic plants in tanks, ponds, lakes or ocean for commercial purpose (Blidariu & Grozea, 2011), and agriculture is the productions of livestock, crops, and plants. Today’s global food production is dependent of fossil fuel, high consumption of water, fertilizers and pesticides, and is not regarded as a sustainable food production system (Frostell, 2015; Godfray et al. 2010). Agriculture face scarcity in arable land, water and energy and at the same time the fishery is overexploited (Godfray et al. 2010). Also, an increase in nutrient leakage to coastal waters adding to the problems of eutrophication is expected as human populations, agricultural and offshore aquaculture production rise (Breitburg et al., 2018).

To decrease the environmental impact, generate new market opportunities, and at the same time use resources more efficiently, an implementation of the concept circular bio-economy (CBE) is often mentioned (Antikainen et al., 2017; Sheridan, 2016). The concept of CBE is a conjunction of the sustainability concepts, the circular economy and the bio-economy (D´Amato, 2017). The bio-economy aims to exchange the fossil-based resources with bio-based resources in materials and as a source of energy (Antikainen et al., 2017; Keegan et al., 2013), and the circular economy focus on recirculating resources (EMF, 2015). To use bio-based resources in a linear way is not sustainable (Reime et al., 2016) and just recirculating resources does not remove the problems with usage of fossil-based materials and energy (Antikainen et al., 2017). Developing the bio-economy and the circular economy together is promoted in relation to the future opportunities in regard of new bio-based products, materials and resource efficiencies, which will lead to a more sustainable future (Antikainen et al., 2017; Sheridan, 2016). Hetemäki et al. (2017) putting the CBE forward to policymakers as the concept that will help us reach the Sustainability Development Goals (SDG) in Agenda 2030 and the Paris Climate Agreement and are seen as an opportunity for business development. They also highlight that collaboration between actors will help the concept of CBE to go “from niche to norm.”

The interaction between aquaculture and agriculture sectors have been promoted as one way of increasing food production, conserving the environment and ensure food security and are in line with the CBE concept (Zabaniotou et al., 2016). These systems has historically been established in South Asia for centuries and is referred to as integrated aquaculture and agriculture systems (IAA) (FAO, 2000; Zajdband, 2011; Oben et al., 2015; Edwards, 1998). The IAA systems are discussed in the perspective that the world is developing in a fast phase, and it is essential to develop food production that considers the resource scarcity and proposes more ecological thinking (Edwards, 1998). Such food production takes care of the side-streams and the wasted nutrient flows. IAA comprises a verity of systems and is defined broadly by Edwards (1998) as systems in large and small scale that are depending on the by-product of one production that becomes an input to another production instead of being wasted. The result is the higher efficiency of output of desired products from the land or water area under a farmer's control. Edwards (1998) argues that the description should be broader. The input can thrive from production on the farm or off the farm depending on needs and opportunity. With this interpretation, the IAA system is not one production system on-site, it can also be interactions between the sectors when taking care of each other’s side-streams and the wasted nutrient flows. Such aquaculture and agriculture interactions (aqua-agro interactions) can be referred to as a sustainable food production system and as an example of CBE development (Carus & Dammer, 2018). Today innovations of the aqua-agro interactions are promoted in the context of sustainability, socio-economic and environmental development (www, FAO, 2017). Several other integrated systems are developed in the aquaculture sector, such as the aquaponics and the multi-trophic-aquaculture that circulate nutrient in closed systems.

Developing food production systems that will help drive the transition to a resource efficient and climate change resilient economy requires a linkage between production and consumption chain with technical, social and organisational innovations (Ronzon, 2012). To succeed in the transformation the farmers will need to change the way they are doing it today, commonly refers to as “business as usual” (Ronzon, 2012). To be able to commercialise the new processes, the new products and capture the value, there is a need to innovate the business models of firms (Antikainen et al., 2017; www, FAO, 2017; Nordisk Ministerråd, 2017).

1.2 Problem

To reach true sustainable business models (SBM), the literature stresses that environmental, social and economic value has to be fulfilled (Antikainen & Valkokari, 2016; Bocken et al., 2014; Bocken et al., 2016; Joyce & Paquin 2016). Furthermore, Neumeyer & Santos (2018) argue that sustainable business model innovation (SBMI), implying that transforming current business models in ways that create significant positive or reduced impact on the environment and society, is still a future perspective than reality. Even though, the challenges of today are regarded as the opportunities for firms and the pressure to respond to the sustainable issues is increasing (Bocken et al., 2016; Joyce & Paquin 2016). To re-design our linear way of handling resources towards a sustainable and circular future, innovation of business model for sustainability is needed. Innovation is about identifying opportunities for development in light of challenges (Bocken et al., 2016).

The concept of CBE represents developments on the macro level, and is promoted as a way of handling the problems of a growing world population that is demanding more resources, which are one of the reasons for resource scarcity, and unsustainable environment (Reime et al., 2016). Aqua-agro interactions share the same underlying push (Zabaniotou et al., 2016). The literature stresses the need for developing CBE, the need for a system view and the need to faster adapt the transition for sustainability in business practices (Hetemäki et al., 2017; Reime et al., 2016; Sheridan, 2016).

The agriculture and aquaculture producers are important players to realise CBE developments (e.g. aqua-agro interactions), however the literature is more focused on the macro-level perspective and very little how firms view such developments in their business practices (i.e. micro-level perspective). Therefore, this study are set to explore the micro perspective to help firms, in aquaculture and agriculture sector, in the on-going transformation to CBE business models with aqua-agro interactions.

On Åland, which is an island in the Baltic Sea and a part of Finland, this type of transformation is promoted in their newly developed regional food strategy (Wiklund, 2017). The aim is to develop more sustainable and circular food production systems with further collaborations between the actors (Wiklund, 2017). The food production on Åland is an important contributor to the community and is dominated by the production of farmed rainbow trout mainly for export and a diverse agricultural sector. For example, there is the production of dairy, meat, and egg, and horticulture niche production (e.g., apples) for export and local consumption as well as small-scale gourmet producers. The aquaculture and agriculture have tampered with the problematic question of how to neutralise its phosphorus and nitrogen emissions because of the strong links to the well-being of the Baltic Sea.

There is a willingness on Åland to develop a functioning circular aqua- and agricultural system, however, it is not in practice. Although there is a stated vision that it will be established in the nearby future. At present, Åland is working to develop the circular system way of thinking among the actors (e.g., aquaculture and agriculture farmers, processing industries) in the food chain. Instead of working from individual circular systems, the suggestion is to implement a more substantial bio-circular business model where several actors can find circular solutions and together contribute to a more sustainable food system.

1.3 Aim and research questions

The study aims to investigate and critically assess the notion of sustainable business model innovation to assist development towards circular bio-economy with a particular focus on aqua-agro interactions on Åland.

The objectives of the study include identifying criteria that form the basis for sustainable business models to attain CBE developments. Further, critically assess criteria of sustainable business model for aqua-agro interaction that can assist development of such initiatives on Åland.

To reach the aim of this study we have defined following research question:

- What are the criteria that form the basis for business model innovation to attain CBE developments?
- What are the relevant criteria for developing circular bio-economy business models with emphasis on aqua-agro interactions?

1.4 Delimitations

This study does not generate a proposition of a sustainable business model. Instead, it focuses on adding to the understanding of sustainable business model innovation with particular referents to aqua-agro interactions as a concept within CBE. By exploring the case of Åland, where the aim is to implement their "Sustainable food strategy of Åland," where they want to develop more sustainable and circular food production systems with further collaborations between the actors on Åland. The study will critically assess criteria relevant to SBMI in relation to aqua-agro interactions.

1.5 The outline of the study

The study is structured in six parts illustrated in Figure 1 to help orientate the reader. The first chapter in the study, the introduction includes the problem background, the problem and the study's aim and research questions. It also includes the delimitations of the study. In the second chapter, the study's approach and the methods used in the research process are presented and discussed. The third chapter includes the literature reviews conducted in the study, the relevant theory is presented and the conceptual framework. The fourth chapter present the case in the study, which is the empirical result of the study. The fifth chapter includes the analysis and the discussion of the empirical results in relation to the study's conceptual framework, and the final chapter comprise the conclusions of the study and the suggested future research.

Figure 1. The outline of the study.

2 Method

In this chapter, the authors of this study describe the research design and explains the methods used to investigate the research questions and argue for the selection of methods that are used. The study assumes a qualitative starting point and includes a literature review within the research field of circular bio-economy (CBE), integration between aquaculture and agriculture, and sustainable business model innovation (SBMI).

2.1 Qualitative research design

This study focuses on exploring the criteria that form the basis for further development of SBMI with particular reference to aqua-agro interactions on Åland. Åland wants to transition from a linear way of producing food to a more circular process where they integrate or find synergies between two or more established food productions. The research questions are therefore of an exploratory character in an attempt to gain further insight in the criteria to further develop aqua-agro interactions. They are composed to find out what actors on Åland make of the concept of circular bio-economy (CBE) and how the firms on Åland can transit to a more circular way of food production. Therefore, a qualitative design that allows for interpretation and increased understanding of a social context and developing process, which in turn generates a detailed picture of the situation, is preferred (Yin, 2009). Such design will generate important insight of a complex social context.

The way the researcher see the world affect the choice of research design and sets down the expectations for the research (Mackenzie & Knipe, 2006; Bryman & Bell, 2015). When identifying the underlying research paradigm, the connection between theory and research, the epistemological standpoint, and the ontological standpoint is taken into consideration. The relationship between theory and research is generally divided by whether the theory is tested or theory is generated. When a theory is generated, it is often recognised as being a qualitative approach to research.

This study started with the idea to study aqua-agro food production on Åland and that firms are important keys to realize CBE developments (e.g., aqua-agro), however the literature did not show how firms view such development. With the qualitative research design, it was possible to evolve the research process as the understanding for aqua-agro interactions further developed along the course of research, generating the aim of the study. The aim generated was to investigate and critically assess the notion of a sustainable business model innovation (SBMI) to assist development for CBE with a particular focus on aqua-agro interactions on Åland. SBMI was chosen because of the need the literature showed for evolving the business models to attain more CBE development, i.e., the firm should not be changing what they do, instead they should change how they do it.

With regards to the epistemological and ontological standpoints, the study can be described as interpretivist and constructivist. Epistemology is described by Carter & Little (2007) and Bryman & Bell, (2015) as what can be justified knowledge, and ontology is concerned with questions about the nature of reality. An epistemological perspective is interpretivism, which focuses on understanding social actions in a subjective way. Enhancing that it is a difference between humans and objectives (Bryman & Bell, 2015). Constructionism relationship to what is regarded as real, in contrast to its counterpart objectivism, regards that social phenomena are also valid knowledge. Interpretivist/constructivist approaches to research have the intention of understanding "the world of human experience" (Mackenzie & Knipe, 2006 see Cohen & Manion, 1994, p.36), suggesting that "reality is socially constructed" (Mackenzie &

Knipe, 2006 see Mertens, 2005, p.12). By exploring the actors (e.g. aquaculture and agriculture producers, associations, authorities and financiers) views on BMI for CBE in the context of Åland, where they operate, the researchers aimed to explore how the actors viewed the world. The results formed the basis for the interpretation made by the researchers and the methods used was chosen to enable a framework for collecting and analysing data that allowed for interpretation. Such interpretive framework and interpretivist/constructivist standpoint the researcher tends to rely upon the "participants"" views of the situation being studied" (Mackenzie & Knipe, 2006 see Creswell, 2003, p.8) and recognises the impact on the research the participant's background and experiences have on the study. Constructivists do not generally begin with a theory, rather they "generate or inductively develop a theory or pattern of meanings" (Mackenzie & Knipe, 2006 see Creswell, 2003, p.9) throughout the research process. This study has a constructionist standpoint although it starts off from the business study discipline, and the notion of studying business model innovation (BMI) for CBE. As the process evolved and became more focused the researchers' interpretations of the social setting was simultaneously developing. By starting off from the business perspective and letting the process evolve, the researchers in this study describe the characteristics of the research process as iterative in the start, instead of the inductive process described by Creswell (2003 in Mackenzie & Knipe, 2006). Or as Merriam (1994) describe the observations in the collected material and the ideas generated with a qualitative design, take the authors through a varied process that ultimately results in a reasonable explanation. Within the qualitative design, there are several approaches and methods to achieve the aim, and in this study, an exploratory case study approach is used.

2.1.1 Case study approach

In this study, a single case study is conducted. The case study approach allows a deeper understanding of the concept and the actors in a specific context (Merriam, 1994; Yin, 2009). The method also creates room for interpretation of an individual's opinions about a phenomenon. The case study conducted can also be described as exploratory, because it investigates a distinct phenomenon characterised by a lack of defined preliminary research and when there are no hypotheses that can be tested (Research methodology, 2017). Instead, the exploratory case study approach is used to answer research questions as "What" or "Who." This study has research questions that start with "What." There are different views on the use of case study research (Bryman & Bell, 2015 see Paavilainen et al., 2009). This study aims to generate an in-depth and holistic picture of the case that can help the researchers understand what the criteria that are significant for innovating the present business models used by aquaculture farmers and agriculture farmers to attain more CBE development. It is an alternative to the positivistic approach promoted by Eisenhardt (1989), where the case is studied with the aim of constructing variables that help in building theory and generalizable propositions (Bryman and Bell, 2015 see Paavilainen et al., 2009). Instead, this study is more in line with the description of an interpretive case study by Merriam (1994). When a case study researcher gathers as much information about a problem or research question as possible, generating a detailed picture, and then develop a typology or, as in this study, criteria that generate a picture of different ways to take on the identified problem.

The contextual setting of the case is also of great importance because a phenomenon cannot be removed from its context (Robson, 2011). When exploring the interactions between aquaculture farmers and agriculture farmers, the context, which they can react to challenges and opportunities, collaborate and develop, is largely affected by the site they are operating at, in this case, Åland.

2.1.2 Choice of case

Åland is the case in this exploratory case study and the unit of analysis. Unit of analysis refers to the primary component of what is analysed in a study (Bryman & Bell, 2015). In social science, the unit of analysis can be an individual or an organisation, it can also be, for example, groups, schools, and perceptions (Vogt, 2005). This study focuses on SBMI and the development of CBE with emphasis on aqua-agro interactions to find criteria that are highlighted in the context of Åland. Therefore, the unit of analysis is the site, Åland. Åland possesses the ability to create aqua-agro interactions because there are innovative primary producers in agriculture and aquaculture on Åland (Wiklund, 2018). They also have a newly developed food strategy that is focusing on the circular economy and promotes to form closed resource loops both in firms, and in particular closing bigger loops on Åland, including several actors and sectors. In regards to the context described, Åland was a suitable choice of case for this study. The unit of analysis should be picked out from the notion of what the researchers would like to understand at the end of the study (Mirriam, 1994, Yin, 2009).

2.2 Course of action

The following parts of the method chapter will describe the steps and the decisions made in the research process, regarding methods of data collection, and analysis. Further describing the literature reviews that been made through the process.

2.2.1 Iterative and inductive research approach

The researchers were introduced to the topic of aquaculture and the possible interactions there are between aquaculture and agriculture prior to the start of the study by Anders Kiessling. Anders Kiessling is a professor at the Department of Animal Nutrition and Management, Aquaculture at Swedish University of Agricultural Sciences (SLU). His research focuses on nutrition, product quality and welfare in farmed fish with emphasis on sustainable animal feed sources, including microbial, insects and mussels. He also has interest in closed integrated and multitrophic farming systems. Prof. Kiessling also became an assistant supervisor of the study. Through the process, he has been an external discussion part, especially regarding aquaculture, circular economy in the perspective of aquaculture, and adding to the thick description of Åland because of his prior and ongoing research activities on Åland. Such role is described as a key informant. They are often found in ethnography and participant research studies (Bryman & Bell, 2015 pp. 455-6). The key informant helps the researcher to get access and can help the researcher to understand the context and the different results. However, the researcher has to be aware that the relation to the key informant can affect the way the researcher sees the social reality.

This study started with an iterative approach to the research process, meaning that the initial thought was to move back and forward between sampling and theoretical reflection, getting closer to the conclusions after every round, until the researchers believed the results to be sufficient. Theoretical saturation arises when no new relevant data is emerging regarding the categories or the relationship between categories is well established and validated, or the categories are well developed regarding its properties and dimensions demonstrating variation (Bryman & Bell, 2015). The starting point was to explore BMI for CBE and the activities were planned to start with semi-structured interviews, where the results were analysed and out of the descriptive picture generated, the researcher would create a set of criteria relevant for discussing innovation of the actors' present business models in a focus group. This course of action is not what the study later in the process took. Instead, the observing of new or less explored phenomena, as CBE and aqua-agro interaction are on Åland, and in research, the inductive approach was found especially suitable (Bryman, 2011; Robson, 2011). To have an inductive approach, when conducting a case study and having a qualitative research design, is the most common approach to the relation between theory and research (Bryman & Bell, 2015 p. 68-67). The study started with doing preliminary a literature review about the three research fields that are included in the study; CBE, Aqua-Agro interactions, and SBMI. After getting a general overview of the research areas, the researchers discussed how the sampling and the data from the case should be gathered. In the process, the researchers identified that the perspective from different actors on Åland were important to be able to create a thick and descriptive picture about what is happening on Åland in regards of the study´s objectives.

The snowballing technique characterises the sampling method in this study. To find relevant candidates for the study, the researchers used the help of the key informant to shape the sample of the study. The researchers started with contacting Professor Kiessling at SLU and held an initial interview (see table 1), which led the researchers to Patricia Wiklund. Patricia Wiklund is the project leader for Åland´s food strategy. She contributed by giving the initial picture about the creating process of the local food strategy and the present situation on Åland regarding the implementation of the strategy objects. Patricia Wiklund also suggested actors on Åland that she believed was suitable to interview after the researchers described the aim of the study. In this way, the researchers got in touch with actors on Åland that had the characteristics relevant to the study, this process is in line with the snowball sampling method explained by Bryman & Bell (2015).

Table 1. Interviews with key informants, date, duration, title, and organisation.

Interviewees	Date	Duration	Title	Organization
Anders Kiessling	2017-12-13 2018-02-16		Professor at the Department of Animal Nutrition and Management; Aquaculture	Swedish University of Agricultural Sciences
Patricia Wiklund	2018-02-20		Creator and director	Invenire AB

2.2.2 Data collection and semi-structured interviews

Data collection is a key aspect of every research, and by doing this inaccurate, the result of the study can lead to invalid results (Hashemnezhad, 2015). Interviews are suitable for studies that follow a qualitative research design (Kvale & Brinkman, 2014). To choose an instrument for data collection, the type of interview method is mostly determined by the nature of the study and has three common types; unstructured, semi-structured and structured (Nunan, 1992; Hancock 2002). This study has applied semi-structured interviews and secondary sources to provide a full picture of the case which Bryman & Bell (2015) imply is a strength to use several sources to collect data. The secondary sources have mainly been obtained through websites to strengthen the picture of the case, Åland. Furthermore, the method of semi-structured interviews when collecting data is common and follows the perspectives and interests of the interviewees which enables the possibility of a deeper understanding of the interviewee´s social reality (Bryman & Bell, 2015; Bolderstone, 2012). Together with observation, it allows understanding of everyday activities of people (Hashemnezhad, 2015) which suited this study well. Semi-structured interviews are characterized by a more general interview guide with open-ended questions compared to what is typically found in structured interviews (Bryman & Bell, 2015). It is a possibility that the interview guide can get open-ended, resulting in missing out essential data. By dividing the interview guide into specific

themes, that risk can be decreased (Bryman & Bell, 2013). The interview guide for this study tried to follow this advice and got constructed from three central themes, identified from the literature reviews to address CBE, Aqua-agro interactions and SBMI. The questions in each theme were then structured in the same way, starting with more general questions followed by more specific ones. The interview guide is presented in Appendix 1 and provides a picture of how the interviews were conducted and how the questions are connected to each theme.
The structure of open-ended questions divided into three central themes suited this study well since it allowed a more open approach to extend the questions for further discussions in the areas the interviewees found important, which also increased the possibility of providing a full picture within the themes. Kvale & Brinkman (2014) and Bryman & Bell (2015) argues for the importance of an open approach for further discussions and the importance of add follow-up questions to clarify the interviewee's answers to increase the possibility of lifting aspects that are not highlighted in the literature.

With the intent of providing a full picture to the study, face-to-face interviews were conducted with all interviewees because of the potential to collect a rich material by the non-verbal expression observations that may lead to further questions (Robson, 2011). Six of the interviews were held one interviewee at a time, at a location chosen by them, which allowed the interviewees to feel comfortable about the interview and to speak freely about the subject without being interrupted by other interviewees. However, one interview was held together with three interviewees (see table 2 row three), because of the interviewees time-shortage. The three interviewees knew each other before and to decrease the risk of affecting each other's answers and being interrupted, the interviewees were only allowed to speak when they got the word. The experience of the interview was that instead of inhibiting to speak freely, the interviewees indicated that they felt comfortable in each other’s presence, which might have helped when discussing the subject. During the interviews, notes were taken to enable follow-up questions, and each interview was recorded with permission from the interviewees. The recording gives the researchers the possibility to go through the answers again and minimize the risk of missing out or losing sufficient data.

Table 2. Overview of the interviewees, date, duration, title, and organisation.

Interviewees	**Date**	**Duration**	**Title**	**Organization**
Sölve Högman	2018-04-04	1 hour	Head of Agricultural Section	The regional government of Åland, Agricultural Section
Sixten Sjöblom	2018-04-05	2 hours	Aquaculture farmer	Storfjärdens Fisk AB
Rosita Broström Jenny Eklund-Melander Lena Brenner	2018-04-05	2,5 hours	Director Fish farmer association. Head of Fisheries Section Rural developer	Ålands Fish farmer association The regional government of Åland, Fisheries Section Ålands rural development center
Henry Lind	2018-04-06	1 hour	Director	The Federation of Producers on Åland
Kristoffer Lundberg	2018-04-06	2 hours	Dairy producer	Haga Kungsgård
Elina Lindroos	2018-04-06	1 hour	Managing Director of Investment Operations	Ålands Utvecklings Ab (ÅUAB)

2.2.3 Qualitative data analysis

To analyse the results from the semi-structured interviews, which is one of the greatest challenges in qualitative research design (Bryman & Bell, 2015), the study applied the method of thematising as the first step in the analysing process. Bryman & Bell (2015) stresses that identifying what the specific data is about, what it represents or what is said to be happening is a helpful method to organise the data. To make the analysing process of the data more comparable at the beginning, the interview guide was divided into specific themes. Since the interviews where recorded, transcription of the data was chosen to reduce the risk of misinterpreting the data (Bryman & Bell, 2013) and miss out relevant information for the analysis (Robson, 2011). Even though transcription is time-consuming (Bryman & Bell, 2015; Robson, 2011), it was important for the study to collect specific sentences and clarify the interviewees' point of view. By transcribing the data, it reduces the risk of incorrect interpretation of the data, however it does not remove the risk. With the intention of lowering the risk of misinterpretation, even more, the focus was to type the exact phrases which decrease the risk of missing out essential information for the analysis (Bryman & Bell, 2015), however padding words that not affect the meaning of the phrases were rejected.

When the transcription where done, the analyses of the data started. Since the interview guide was divided into themes, the ground for thematising of each interview was set and only needed structure and organisation to get the answers in chronological order. The chronological order was necessary for the comparison of the answers in order to reach a more sufficient data analysis.

2.2.4 Literature Reviews

To clarify the concepts of CBE, aqua-agro interactions and SBMI, a cluster of literature covering these topics was collected. The literature review helps the researchers understand what is known and what existing research and literature there is within the concepts and theories to create a more extensive theoretical understanding and insight of different perspective (Fetters et al., 2013). The literature review opens the possibility to find an area in theory that has not been explored earlier, referred to as gap spotting (Alvesson & Sandberg, 2011). For this study, a broad literature review was conducted to construct the conceptual framework for this study and provide different perspectives on the problem (Bryman & Bell, 2015). In turn, this guided the study into a more relevant analysis of the collected data (Robson, 2011).

When conducting the literature review, there is often two different ways mentioned, systematic or narrative (Bryman & Bell, 2015). For this study, it was needed to enrich the knowledge within the research field as the study progressed and therefore a narrative review suited this study well. The narrative method of conducting the literature review is less strict in its form compared with the systematic literature review and enables the possibility to find new and more in-depth understandings of the subject (Yin, 2009). To find literature, sites like Google Scholar, Scopus, Web of science and SLU Library database – Primo has been used. The keywords got developed from the aim and research questions to find relevant literature (see table 3). Additional keywords were found by using the reference lists in informative studies to find further literature of interest for the study. The before-mentioned process can be described as a snowball method (Bryman & Bell, 2015).

The result of the literature review formed the basis for the analytical labels used in the conceptual framework. To ensure the quality of the literature review and increase the study´s trustworthiness, the literature was sorted after if it was peer-reviewed, its relevance and if it was well-cited and discussed.

Table 3. Searched keywords for literature review and theoretical framework.

Search words		
Economy +	**Aqua-agro+**	**Business model innovation+**
Circular	Production	Sustainable
Bio-	Integrated	Circular
Circular Bio-	Food production	Circular bio-economy

2.3 Method discussion

The choice of methods when conducting a study is many, and there is probably no such thing as the perfect method (Bryman & Bell, 2015). Therefore, it is essential to reflect how the choice of a method could affect the study and how it was carried out to ensure the quality (Robson, 2011). The following section provides a discussion about the chosen methods, how it could affect the quality and how this study tried to prevent the quality impact.

2.3.1 Case study

Occurring criticism against the choice of a case study research method is that the results are not considered generalisable (Bryman & Bell, 2011, p. 408). Critics point out that the conclusions that emerge are taken out of its specific context, and it is impossible to know whether the discovery can be considered to be generalisable to other contexts. That a case study cannot be generalisable opposes Flyvbjerg (2006). He emphasises that it is a misunderstanding that is widely extent and is incorrect, as a discovery from a single case could be significant to contribute to research in a generalizable way. If something is found to exist, it should be sufficient to state that it exists without showing a number of results that reinforce the discovery. Further arguments explaining that generalisation will not be possible in a study with a quantitative design with only one result, however the result is enough to generalise in a case study (Yin, 2009, p. 43). The qualitative research can achieve generalised contribution to the theory agrees with Bryman & Bell's (2011, p.409) discussion about qualitative studies' generalisability. The barriers to generalising the results are instead a lack of stringency in the theoretical reasoning and the implementation of the study.

2.3.2 Interviews

To find suitable interviewees for this study the method of snowballing was used. When using this method, the weakness of generalisation can arise because of the role that the key informants have (Bryman & Bell, 2015). When using key informants to find suitable interviewees, there is a risk that the interviewees think alike and therefore give an angled picture of the reality that is studied. To decrease the risk, the key informant was asked to find interviewees with different roles in the category of aquaculture and agriculture to be able to generate a picture with different perspectives of the studied subject. The researchers also told the interviewees who sent them, and they also told the interviewees who they already or was about to interview. In this way, the researchers got an overview of the relations between the interviewees, which helped them understand the context better. An example is that the agricultural farmer was found out to be very innovative and expansive, and may not represent the general farmer on Åland. A further example is that all of the interviewees knew whom the key informant was because of the newly developed food strategy. The fact that the interviewees were aware of the food strategy is believed to have contributed positively in gathering relevant data for the study because all the interviewees were updated and had a forward-looking perspective.

Furthermore, by using interviews as a method to collect data, different weaknesses can arise (Bryman & Bell, 2015; Yin 2009). For example, the generalisability of the result can be difficult to achieve when using few interviews, however Kvale & Brinkman (2014) argues that the characteristics of the interviewees are more important than the number of them. When conducting the interviews, there is also a possibility that the interviewees try to give the answers they think the study needs (Robson, 2011) and with poor interview technique, bias responses can arise (Bryman & Bell, 2015). In trying to avoid these weaknesses, the researchers tried first to find as many different suitable characteristics as possible rather than focusing on the number of interviewees. Secondly, the semi-structured interview method was conducted to develop open-ended questions to minimise the risk of the researchers influencing the answers and avoid asking the interviewees leading questions. Moreover, the interview strategy of different roles was conducted during the interviews, which means that one of the interviewers was more passive and taking notes and the other more active and asking more questions (Bryman & Bell, 2015). In this way, it allowed the passive interviewer to ask follow-up questions regarding unexpected topics when the interview turned in different directions.

2.3.3 Quality assurance

By using a case study approach, it is possible that the result can be difficult to generalise though it based on a specific context (Bryman & Bell, 2015). Because of the criticism, it is especially crucial to ensure the quality the method entails (Yin, 2009). Even though, Eisenhardt (1989) concluded that the case study approach was exceptionally well suited for new research because of its independence from past empirical observations and prior literature. To evaluate the quality of a qualitative study, Bryman & Bell (2015) presents Guba & Lincoln (1994) trustworthiness and authenticity as a different way to assess the quality. Bryman & Bell (2015) mean that the usual criteria, reliability, and validity, are defined very similarly as in quantitative research, saying that it requires an absolute truth of the social reality. In another hand, Yin (2009) argues that the reliability and validity criteria are suitable and suggests some adjustments. Furthermore, Mason (1996) means that these criteria are different measures in quantitative and qualitative research. However, to motivate and explain the quality of this study in a suitable way, trustworthiness and authenticity were chosen to give the reader a correct picture of the quality assurance and are presented in Table 4.

Table 4. Overview of quality assurance criteria.

Trustworthiness & Authenticity criteria	**Examples of Suggested techniques**	**Applied in this thesis**
Credibility	Interviewees validation - reduces the possibility of misunderstanding	Sent conclusions of the interviews to the interviewees for validation
Transferability	Thick description – sufficient amount of details of a culture	Providing a thick picture of the case Åland & empirical data
Dependability	Description of the research process	The method chapter aims to give the reader a description of this thesis research process
Confirmability	Clearly shown that personal assessments or theoretical orientation influenced the conduct of the research	The authors have acted in good faith, and the thesis has been read by several students and by the supervisors.
Fairness & truthfulness	Present different viewpoints from the interviewees to provide a fair picture.	Interviewees validation has been made to erase misunderstandings and ensure a fair picture of the interviewees
	Control if the interviewees gave truthful and genuine answers	It was difficult to control if the interviewees gave truthful and genuine answers at fully. The experience was that they did and that the open-ended questions helped. The authors also tried to control specific facts that were given through internet sources and everything corresponded.

2.4 Ethical Considerations

Ethical consideration is essential when conducting, writing and reading a study performed with a case study approach because of the notion of biases (Merriam, 1994). Therefore, the researchers need to consider the benefits against the disadvantages of the methods used when conducting a case study and be sensitive to the technics and the context. The researchers' sensitivity is a quality that is important, especially in the data collection using interviews, knowing when to ask further questions and when not to follow a track that is not relevant for the study, often referred to as "the timing" (Merriam, 1994). In the data collection carried out in this case study, the interviewees have been told in advance what the study was aiming to understand further, and the interviews were sent the interview guide in advance. They were also told who gave us the notion about them, the key informant, Patricia Wiklund. During the interviews, the interviewees were asked if they wanted to add anything that the researchers had not asked and they also got the opportunity to change, add or withdrawal any statements when sent the summary of their interview. Also, known as interviewee validation, a technic to strengthen the validity of the study (Bryman & Bell, 2015).

3 Theoretical perspective and literature review

This chapter aims to provide the reader with an understanding of previous research within the concept of circular bio-economy (CBE) and aquaculture and agriculture interactions as a concept of circular bio-economy. Further, we present the concept of sustainable business model innovation. At the end of the chapter, the literature reviews of the three concepts are conceptualised into the framework that will be used to help address the research questions of the study.

3.1 Two sustainability concepts that are combined into one, the Circular bio-economy

In the transformation where firms need to change their present way of doing business and create more sustainable business models one concept that is gaining more attention is the circular bio-economy (CBE). It is a concept emerging out of the integration of the concept of the circular economy (CE) and the concept bio-economy (BE) (Carus & Dammer, 2018; Hetemäki et al., 2017; Sheridan, 2016).

3.1.1 From linear to a circular economy

The concept of CE is characterised by material loops that eliminate waste by keeping the resource within the system by using components or products multiple times (e.g., second hand, re-cycling) (EMF, 2015). The concept of CE is not new however has with help from the Ellen MacArthur Foundation (EMF) gained attention in the academic, business, political and consumer perspectives. EMF (2015) defines the principles in the CE as reuse, repair, refurbishing, and recycling of the existing materials and products; "what was earlier considered to be waste becomes a resource." The aim is to change our current linear usage of resources to circular ones. The current linear use is when we produce products that are not designed for reuse nor recycling, and the product becomes a waste that we do not generate any further value of. This system is often referred to as the “take-produce-consume-discard process.” The linear system is threatening the economic stability by the over-exploitation of non-renewable resources and at the same time damaging the environment (EMF, 2015; Jurgilevich et al., 2016; Ghisellini et al. 2016). In the transition from linear systems to a more circular one, the aim is to lengthen the usage, and maximise the value of the products and minimise the waste (www, ec.europa., 2018). The concept of CE is widely acknowledged, and the transition is strengthened by policy-making and government strategies around the globe (Sheridan, 2016; D´Amato et al., 2017). For example, the European Commission´s Circular Economy Strategy and the following Action Plan, that is promoting a long-term strategy that will contribute to "closing the loop" by putting up goals and measurements for re-use and recycling, and proposals on legislation to handle waste (EC, 2018).

3.1.2 Bio-economy

As for CE, the concept of bio-economy (BE) is also acknowledged in policy agendas around the globe and research (Viaggi, 2016). Like CE the BE is regarded as a solution for the growing concerns for climate change, scarcity in resources and food security (Viaggi, 2016; Jurgilevich et al., 2016) and to merge economic, environmental and social goals (D´Amato et al., 2017). The BE concept takes inspiration from biological models and links it to the economic perspective. Although the BE concept is widely acknowledged, the researchers within the area are struggling to find a standard definition (Keegan et al., 2013; www, ec.europa., 2018; Rönnlund et al., 2014; Reime et al., 2016). The concept is often explored in relation to other closely related concepts, like sustainability, circular economy, ecosystems services, green economy and agro-ecology which may have added to the definition problem (Viaggi, 2016). From a political view, the BE is more frequently defined as a “sustainable and circular bio-economy.”

Characteristics in the definition of BE refers to producing, for example, food, feed, materials (e.g., bio-plastic and textile), products, and energy, included waste and by-products, from renewable biological resources from land and sea (Cavallo & Gerussi, 2015; Keegan et al. 2013; Carus & Dammer, 2018). The production of biomass should aim to replace the use of fossil-resources in materials and as a source of energy, making the world more independent of fossil-based resources. BE emphases environmental and economic benefits and aims for higher resource efficiency and sustainability (Antikainen et al., 2017; Keegan et al. 2013). Within the research field of bio-economy new technology and innovation are the main focus (Keegan et al. 2013). Therefore, the BE enables possibilities for development of innovative new industries with higher resource efficiency. To accomplish a growth of BE, innovations linked to sustainable development are essential drivers (www, ec.europa., 2018). Innovations linked to the circular economy are one prominent way.

3.1.3 Circular bio-economy (CBE)

The two concepts, circular economy, and bio-economy are gaining more acknowledgment at different stakeholders, in different research fields, and policy-making. Both concepts are regarded as new ways of thinking that will enable the development of a more sustainable world (D´Amato, 2017). The two concepts have developed in parallel to each other although are interlinked more frequently and are promoted to be further developed in such direction (Hetemäki et al., 2017; Reime et al., 2016; Sheridan, 2016). Why CBE as a concept is gaining more attention can be a result of the developments within bio-economy that are promoted to be more circular (Hetemäki et al., 2017; Rönnlund et al., 2014). That the concept is starting to gain more attention is shown in the rapport by Reime et al., (2016), "The circular bio-economy in Scandinavia." They found that the concept of CBE was not well established in Scandinavia and instead they described the concept as new and growing. However, they also found that the concept of the BE and CE is closely related and that it is sometimes argued that the bio-economy are circular in its nature. Reime et al., (2016) mean that it depends on the treatment of by-products and waste streams in the BE, which should be highly valorised and treated optimally. For example, the biomasses should not be used as waste incineration or landfill. In those cases, bio-economy cannot be regarded as circular. The ones that are regarding BE to be circular in its nature are instead focusing on the fact that it incorporates renewable resources (Sheridan, 2016). Resources that can decompose and regrow into new resources within a timeframe that is relevant. Allen (2016) clarifies the discussion, “*it is still possible to use biological resources faster than they can be reproduced, and as such, the bio-economy can be functionally quite linear in practice, even if circular in principle.*” (Allen, 2016 p. 196).

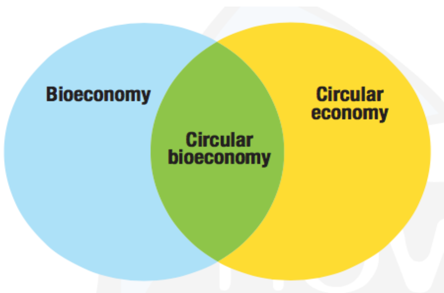

Figure 2. Circular Bio-economy (Carus & Dammer, 2018, in Pursula &Carus, 2017).

Collaborations within the CBE concept

To be able to change the current view on how to use and produce bio-based products more circularly, the collaboration between sectors and actors are promoted. Collaboration within and between different sectors, described as cross-sectoral collaborations, are highlighted by researchers and policymakers to be important in the transition to a more CBE development (Allen, 2016; Bezama, 2016; Reime et al., 2016).

The collaboration will enable the actors to take advantage of the opportunities within CBE and face the challenges (Reime et al., 2016) and will help the CBE concept to go "from niche to norm" (Hetemäki et al., 2017). The cross-sectoral approach is regarded both on a local level, regional level, and international level. Depending on the conditions, for example, what natural resources there are, the local supply and demand and infrastructure is shaping what sectors that have strong ambitions to develop activities, industries, policies in line with the CBE concept (Carus & Dammer, 2018). For example, in Norway, the stakeholders in the marine sector are taking the initiative together with the government (Reime et al., 2016). Compared to Denmark where the agricultural industry and the biorefineries are the most prominent sectors, and the approach is more business and export orientated in regards to developing the CBE concept. Compared to the Swedish and Finnish approach that is more concerned with innovation and research, where the industrial sectors, as forestry have played a central role (Reime et al., 2016; Antikainen et al., 2017). Even if there are regional differences, there is a need for international collaboration of activities and innovation centres (Reime et al., 2016), which will improve knowledge through research and sharing of best practice (Allen, 2016). Further, improved stakeholder engagement, policy interaction, and development of markets in the bio-economy and the circular economy will be needed in the transition.

In this transitioning process, researchers stress the needs of policymakers and governments to make long-term strategies, and the industries and primary producers need to change production processes and the way of designing and innovate their business models. Also, consumers play a significant part in the adoption of a new concept (Allen, 2016). Consumers need to be a part of closing the loop; by using the services as recycling the products they are using and in the first place choose the products and materials that are promoted.

The use of resources within the CBE concept

The usage and design of bio-based sources determine if it can be regarded as CBE. The biomass should not be used as energy in the first, neither the second step, instead it should remain in the economy as long as possible. The notion of adding steps in the value chain in relation to the bio-economy is often referred to as cascading.

The cascading use

The concept of cascading is frequently mentioned in the bio-economy research (Keegan et al., 2013) especially in the forestry sector (Mair & Stern, 2017). Cascading biomass is regarded as a concept that is overlapping the concept of the circular economy (Carus & Dammer, 2018). As in the definition of CE and BE there exist a discussion of what cascading is and how it influences the firm, at the same time cascading, have been identified as a cornerstone of CE and BE strategies (Bezama, 2016). Cascading is described as a mechanism to maximise the effective use of bio-based resources by prioritising making materials and products instead of using biomass as an energy source (Mair & Stern, 2017). In relation to the food industry, that is a sector developing in line with the concept of CBE, and are concerned with waste and by-products that are promoted to be taken care of in a more circular way (Carus & Dammer, 2018). It is the notion of "upcycling" (rather than recycling), so instead of producing energy from bio-waste, they produce for example feed to the aquaculture industry of waste from the food processing industries. So, the cascading promotes upcycling, where more valuable outputs are created from waste streams. A further example from the food industry is the cascade of side-streams from aquaculture production where firms are making new high-value products of discards from fish (e.g., omega-3 capsule) (Carus & Dammer, 2018).

Bezama (2016) describe cascading as a measurement of materials in a production system that can be re-circulated. The information is used to close the material loops or at least improve the material usage in the production system. Mair & Stern (2017 see Sirkin & ten Houten, 1994) stated that the cascade concept should apply to the utilisation of all resources, not only the resources in the forestry sector where the concept origins. In a perspective of CBE, the concept of cascading should be encouraged (Carus & Dammer, 2018). Today only about 15% of the biomass that is used in the European Union is available for cascading. The reasons are that the materials and products are not constructed in ways that make it possible to use them as materials again. Instead, several energy policies in EU are promoting to make bio-based energy of used biomasses, which lead to single cascading and the result is a loss of resource efficiency.

The challenges in cascading are related to the need for data of the biomass flows to be able to assess if cascading is the most efficient thing to do (Carus & Dammer, 2018). Because additional energy is needed in the process of cascading and depending on the resources needed to cascade it can result in a less resource efficient alternative. For example, cascading in the agricultural sector, in some situations it could be more efficient to use the biomass as a soil improvement. Carus & Dammer (2018) also stresses the need for logistics to connect different sectors.

A further issue that is discussed when promoting CBE development is the legal framework (Carus & Dammer, 2018). The framework that regulates the system of use of biomass need to be in line with the cascading principle, and one particle concern is the policies focusing on "waste to energy," (e.g., the bioenergy and biofuels policies). The phrase, "waste to energy" refers to situations where waste is burned instead of recycled. In those cases, waste reduction and valorisation in other value chains will not happen.

Waste and side-streams are transformed into new income streams

Sheridan (2016) emphasise that there will be many opportunities for growth and political support if bringing the CE and the BE together. Transitioning to the CBE concept will lead to more sustainable resource use at a lower cost while developing new income streams (Allen, 2017; Keegan et al., 2013). By utilisation of organic side and waste streams from, e.g., agriculture, forestry, fishery, aquaculture, food and feed and organic process waste to create new products and materials, such as aquaculture feed or as chemicals (Carus & Dammer, 2018). By supporting the development of new sectors, adding value to products and creating jobs (Allen, 2016; Sheridan, 2016). Achieving this will not be easy, it will involve a change in the way we think about resources and wastes, however the potential opportunities are substantial (Allen, 2017). Improvement of resource efficiency and waste reduction, coupled with new products, services, and business models are likely to offer these new opportunities. The present business models may require radical changes in the design of products and services to fulfil the principles of a CBE (Antikainen et al., 2017).

3.2 Aquaculture and agriculture interactions, a concept of CBE

The concept of CBE is wide and comprises several different sectors, in different levels in the value chain of bio-based materials and products. Aquaculture and agriculture are primary sectors in the food industry that are vital in the transition to production in line with the CBE concept. The growing interest in CBE, research initiatives where residues and side streams in the food value chain (e.g., potato peal, fish discards, whey from dairy industries, and consumer food waste), and other bio-based value chains are explored in the pursuit of closing the loops, as in circulate the resources by making use of them instead of discarding them (Zabaniotou et al., 2016).

3.2.1 The traditional way of handle side streams and waste in the aquaculture and agriculture sector

Different research fields, such as industrial symbioses and rural development (Fraccascia et al., 2016; Prein, 2000) are interested in the conjunction of aquaculture and agriculture. The two research fields that been in focus for decades are Integrated Aquaculture and Agriculture Systems (IAA) and aquaponics (Little & Edwards, 2003).

The systems that were used for centuries in Asia is to integrate pond culture into different farming systems by using techniques which rely almost exclusively on the recycling of by-products from animal and crop production (FAO, 2000; Prinsloo et al., 1999; Little & Edwards, 2003). The most widespread and conventionally recognised type of integrated farming is the direct use of livestock production wastes (Little & Edwards, 2003), such as using the manure as a nutrient in the water that increases the biomass that the fish feeds of. Another IAA system with a long history is fish in rice fields (Prein & Ahmed, 2000). In the rice fields, the farmers planted fish that nourished from the algae and became an extra output used for sales and the family food security. Therefore, the phenomena of IAA food production systems are often encountered in rural areas where the resources often have been scarce, and there is a high need for more resource efficient ways of food production (Prein & Ahmed, 2000). Large parts of the research within the field of IAA focus mainly on the opportunities of implementation in developing countries, rural areas, with small-scale or household farmers, with limited resources (Little & Edwards, 2003; Oben et al. 2015, Prein & Ahmed, 2000).

Today innovations of the IAA systems are promoted by FAO (www, 2017) in the context of sustainability, socio-economic and environmental development. When pushing for innovation within IAA, the factors that are highlighted are the need for supporting farming technology and management practices to be able to scale up the business models. In other research fields, as industrial symbiosis (IS), the researchers put forward that actors do not have sufficient awareness about how to integrate the IS practice into their current business models and how to gain economic benefits from IS (Fraccascia et al., 2016).

3.2.2 New ways of thinking about side streams and waste in the aquaculture and agriculture

Cascading

Aquaculture and agriculture are two economic sectors in the BE. To find synergies between aquaculture and agriculture the sectors are explored in the light of sustainable food production, the growing food scarcity and resource scarcity (e.g. water and arable land) and the possibilities within recycling and closing the loops (Bosma et al., 2006; Carus & Dammer, 2018; Edwards, 1998; Graber et al., 2014; Stevens et al., 2018). It is not only the forest sector that offers the potential for cascading use (Carus & Dammer, 2018), the oceans and seas offer the potential for the cascading use in the BE. For example, the use of discards from fisheries and aquaculture will create new products. One example, from the fish industry where they have used the fillets and produced different products to meet the consumer needs, (e.g., as fresh, frozen, slated, dried, smoked or in other ways processed) and the rest of the fish, as the bones, intestines, and skin have been seen as waste and been thrown away. The current view of fish waste is changing rapidly where the industry is starting to see the waste as a new resource to make use of, i.e., creating value. For example, the skin of the fish is used in medical products and cosmetics and, the fish frame can be used as bioactive compounds as fertilizers and feed for microorganisms that are used as feed in aquaculture. Other sectors that also are identifying residual currents in the perspective of developing cascades are concerned with food waste from consumer consumption, waste from the food industry and organic waste from the agricultural and forestry (Bocken et al., 2016; Keegan et al., 2013; Nordisk Ministerråd, 2017).

Creating loops

Trends in aquaculture research are to find possible ways of bringing back the nutrient leakage by creating loops, and one way is to develop cycle-based feed (Frostell, 2015; Hamilton et al., 2015). For example, taking residues from the forestry sector as sawdust to grow microbes and jest, then processing the microbes to fish feed or poultry feed (Backlund & Nordström, 2014). A similar example is the project Vega Fish in Sweden (www, F&F, 2015). By feeding the bacteria with organic matter, like peas, the microbe in return becomes feed for fish or shrimps and also clean the water. The residues from the fish or prawns can later produce biogas, and the biogas sludge can be applied to the fields as fertiliser for more peas. Other examples regarding cycle-based feed, is to use food waste to produce maggots and insects that are processed to feed (Lalander et al., 2015; Nrk, 2017). The waste can come from food waste in the food industry, i.e., producers, processors, wholesale, and later from consumer wastes.

One form of aquaculture is to producing macroalgae or mussels that are a good protein source for humans, in animal feed or can become organic fertiliser on land (Nordisk Ministerråd, 2017). One example of such production system is the integrated multi-trophic aquaculture (IMTA) (Ashkenazi et al., 2017; Troell et al., 2009). The aim is to mitigate the environmental impact when developing these systems (Edwards, 1998). The system integrates fish, inorganic and organic extractive species (e.g., seaweed and shellfish). The system reduces the extent of nutrients released from fed aquaculture species (e.g., fish), by the integration of extractive species from other trophic levels. This approach allows the waste material of the fish production to become a viable resource for an added valued marine crop, instead of spreading and harming the environment.

A further example of integrated systems between aquaculture and agriculture are aquaponics (Graber et al. 2014; Kloas et al., 2015). Aquaponics is the integration of recirculating aquaculture (RAS) and hydroponics in one production system (Somerville et al., 2014). RAS is a closed system where water is reused for the fish after a cleaning and a filtering process. Hydroponics is soil-less systems where cultivation of plants is conducted in nutrient-rich water. When combining the two systems, an creation of a polyculture of fish in tanks and plants (e.g., tomatoes, cucumbers, aubergine) that are cultivated in the same water circle (Graber & Junge, 2009; Rakocy et al., 2006). The primary goal of aquaponics is to reuse the nutrients released by fishes to grow crops (Blidariu & Grozea, 2011). Benefits of aquaponics are that the dissolved waste provides nutrition to the crop cultivation, reducing discharge to the environment and counteract the eutrophication problem (Rakocy. et al., 2006). The use of aquaponics is often promoted in areas where the soil is poor, and water is scarce, for example, in urban areas, arid climates and low-lying islands (FAO, 2016; Goda et al., 2015). The size of the systems varies from small-scale production as a hobby to diversifying an established aquaculture or greenhouse production, up to commercial production (Rakocy. et al., 2006; Goda et al., 2015). Commercial aquaponics of larger scales are not appropriate in all locations, and many start-ups have failed (FAO, 2016). There is a current struggle to make profitability in these new high technology systems (Rakocy. et al., 2006, Somerville et al., 2014; FAO, 2016). It is related to the fact that the high technology RAS is recognised to need substantial capital investment, high level of knowledge, consistency, and reliability of inputs (e.g., fish feed and energy) and a market willing to pay a premium price because of the higher production costs. To develop these systems, the needs for new business models are substantial.

3.3 Sustainable business model innovation

In relation to the descriptive pictures of the concept of CBE and aqua-agro interactions given in the first two parts of the theory chapter, the following part of the theory chapter focus on sustainable business model innovation (SBMI).

3.3.1 Business model

The theory of business model (BM) is not new, and several perspectives are used in the literature to describe and discuss the BM (Bocken et al., 2014; Joyce & Paquin, 2016; Neumeyer & Santos, 2018). BM is used to understand how firms operate to create value and focus on how the firm works to generate value for the firm and customers. Joyce & Paquin (2016) define BM as *"the rationale of how an organisation creates, delivers and captures value."* (Joyce & Paquin, 2016 see Osterwalder & Pigneur, 2010, p.14). The value refers to the maintained economic benefits (Bocken et al., 2014) and it is a difference in creating value and capturing value (see figure 3) (Bocken et al., 2014; ISU, 2004). Creating value or value-adding is generated by actions that develop benefits, for example, exceed the costs or when an action is made to reduce cost. Examples that can create value for a firm are new production techniques, product development, quality and quantity of products, service, market analysis, selling skills and job safety for the employees. Value capturing for a firm is the selling price, which generates the profit for the firm and the product or service the firm delivers are the value proposition. Through actions that change the value chain, the firm can capture more value from the product or service. Agriculture can illustrate the difference between creating value and capturing value. Farmers create value by planting and growing crops. Creating a valuable crop (value proposition) does not do any good for the firm unless the crop is harvested and sold. In other words, the value is captured when the crop is harvested. Actions to hopefully capture a higher value can be to sell the product directly to the consumer instead of through a retailer.

Figure 3. Value boxes (Bocken et al., 2014, own illustration).

3.3.2 Sustainable business model innovation (SBMI)

Today it is possible to divide the field of BM into conventional and sustainable ones (Neumeyer & Santos, 2018). Sustainable business model (SBM) can be seen as a sub-category in the theory of business model (Antikainen & Valkokari, 2016) referring value not only to economic but also to social and environmental benefits (Antikainen & Valkokari, 2016; Bocken et al., 2014; Lewandowski, 2016). Joyce and Paquin (2016) mean that environmental impact should not be measured in just different emissions, impact should also be measured in ecosystem impact, biological diversity, human health and water use. Bocken et al., (2016) suggests that different strategies (i.e., technological, biological, long-life products and life-extended designed products) can together reinforce sustainable resource flows. In order to achieve that, the need for education and awareness of sustainability is essential to develop a successful SBM (Bocken et al., 2014). Bocken et al., (2016) argues that business model and design strategies have to go hand in hand and probably with multiple tools, business models, design strategies, and methods, to support the development. Bocken et al., (2014) mean that sustainable business model innovations (SBMI) may not be economic defensible at the beginning however stresses that many new green inventions are not. The interests in social and environmental benefits have evolved during the last decades resulting in different research streams within SBMI. This has resulted in ambiguous definitions of SBMI in the literature (Bocken et al., 2014), although in general they have in common that the firm does not need to change what they do, instead they should change the way they do business (Bocken et al. 2014 see Amit & Zott, 2012).

> *"innovations that create significant positive* and/or *significantly reduced negative impacts for the environment and/or society, though changes in the way the organisation and its value-network create, deliver value and capture value (i.e., create economic value) or change their value proposition."* (Bocken et al. 2014, p.44)

Sustainable business model archetypes

Furthermore, there is a lack of supportive tools that encourage SBMI in firms, and the current tools do not consider the changing business environment and the need of breaking existing value chains (Antikainen & Valkokari, 2016; Joyce & Paquin, 2016). To accelerate the development of SBMI, Bocken et al., (2014) synthesised findings in literature and business practice into eight different archetypes, with the aim to explain and define mechanisms for assisting the business model innovation for sustainability. The archetypes are distributed into three types of innovation-oriented groups inspired by the previous categorisation by Boons and Ludbeke-Freund (2013). The groups are; organisational, social and technological (See figure 4).

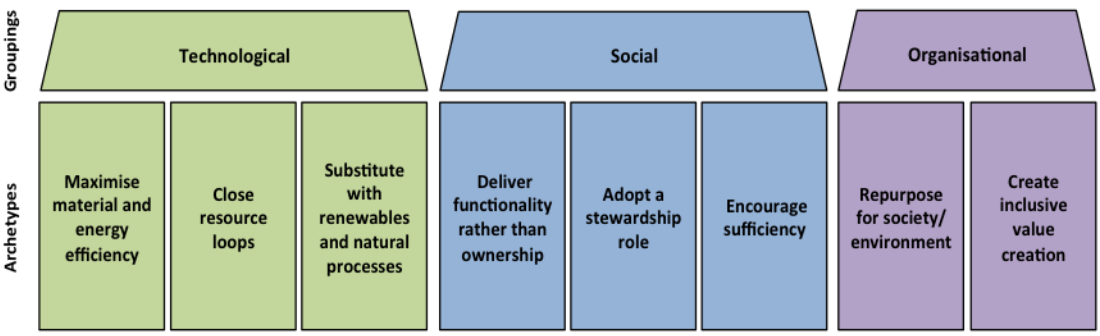

Figure 4. The Sustainable business model archetypes (Bocken et al., 2014).

The organisational group
The organisational group includes two of the archetypes and are described by Ritala et al., (2018) as economical. The innovation focuses on changing the structure of the business for sustainability by maximising delivering sustainable solutions for social and environmental benefits (Bocken et al., 2014). One archetype is about changing the purpose of the firm to put forward the social and environmental benefits before the economic benefit of stakeholders. Examples of innovations characterised in this archetype are social enterprises and shared ownership. Another is "inclusive value creation," and is about firms sharing different resources and becomes sustainable by for example sharing platforms (Ritala et al., 2017). In the literature review, the development of aqua-agro interactions does not aim to change the purpose of the firms involved. Instead, the underlying opportunities they explore is motivated by gaining new valuable products that generate economic benefit for the firms (e.g., making fish feed of food waste) There is no change in ownership structure nor financial goals. The environment is put forward as the reason for changing current linear systems and the need of producing sustainable food, however the underlying motives to make a profit is not changed.

The social group
The second group identified by Bocken et al., (2014) is the social group including three of the archetypes. It engages in the "users" needs and well-being. For example, offering premium products by creating a brand that engages the consumer in value chain issues (Bocken et al., 2014 see Fairtrade, 2011), or making the consumers more aware of recycling options or the impact of overconsumption. Another example is that the firms are adopting a stewardship role that addresses a specific environmental or social issue (Ritala et al., 2017). In relation to aqua-agro interactions, the innovations are not focusing on changing the consumer behaviours or changing the consumer offerings in relation to the aquaculture or agricultural products that are offered. Instead, the innovations in regards to aqua-agro interactions are characterised by the third and final innovation group by Bocken et al., (2014).

The technological group
Thirdly, the technological group is about maximising the material and energy efficiency; eliminate the concept of waste by turning it into a valuable input to other productions and closing the resource loops (Bocken et al., 2014). The archetypes in this group have a technical innovation part (e.g., manufacturing process). In the literature of CBE development, the firms focus on transform the present way of doing business by creating resource loops and by utilizing and maximise the value of resources by cascading (Allan, 2016). Ritala et al., (2017) refer the archetypes in this group as environmental, focusing on innovations that generate environmental benefits or reduced environmental impact. In relation to the initiatives in aqua-agro interaction development, the usage of each other's waste stream as input is highlighted and the cascading of the aquaculture value chain are as prominent as the bio-energy developments are to agriculture.

The technical group/ the environmental archetypes are three;
- *Maximize material and energy efficiency*
- *Create value from "waste"/closing resource loops*
- *Substitute with renewables and natural processes*

The sustainable business archetype – Maximise material and energy efficiency

The definition of the archetype is "Do more with fewer resources, generating less waste, emissions, and pollution" (Bocken et al., 2014 p.48). The focus on this archetype is predicted to generate more and more interest, especially in the industrial sectors, because of the increased resource scarcity and the enhanced energy prices (Bocken et al., 2014). The environmental impact is reduced by lowering the firms demand of energy and resources which indirectly lead to reduced extraction and depletion of resources and reduce waste and emissions. In that way, the firms contribute to a system-wide reduction of resource usage, in comparison to the commercial fundament of the innovation processes of production and product redesign, which focus on maximising material and energy efficiency to be able to generate a better value proposition (e.g., creating price reduction to the consumers). Examples that are highlighted in relation to this archetype by Bocken et al., (2014) is lean manufacturing (e.g., waste reduction, minimising over-production, improved material handling), and cleaner production approaches. Environmental benefits and economic objectives can be obtained in relation to this archetype. However, regarding social sustainability benefits it is generating problems by reducing workplaces that indirectly is leading to unemployment through the improved productivity and efficiency (Bocken et al., 2014 see Ashford et al., 2012).

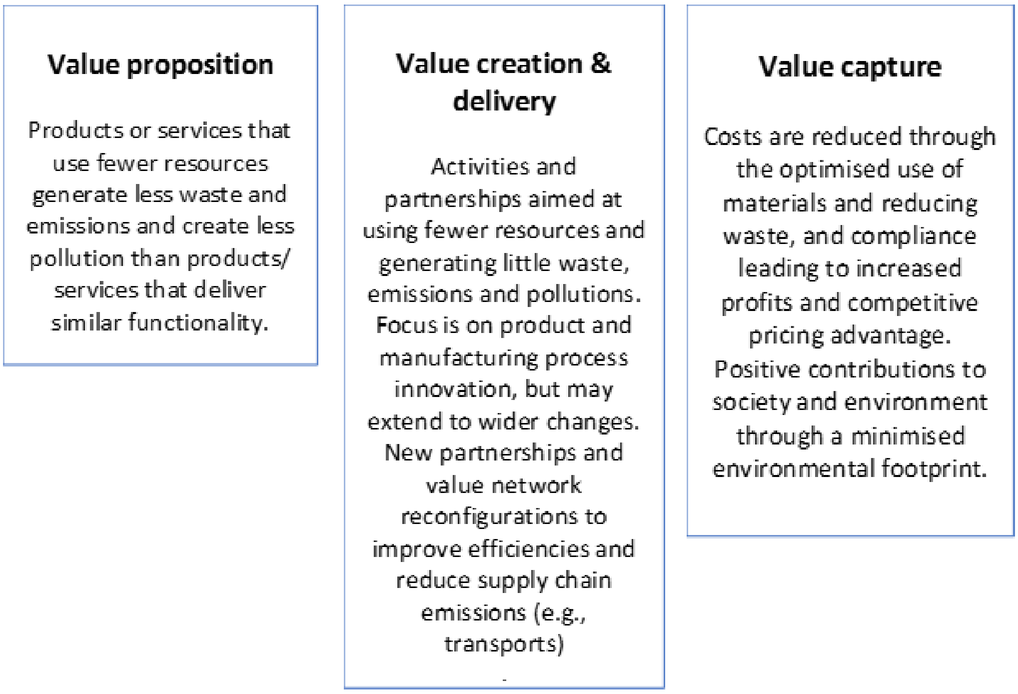

Figure 5. The value boxes of the archetype Maximize material and energy efficiency (Bocken et al., 2014, own illustration).

The sustainable business archetype - Create value from "waste."

The definition of the archetype Create value from waste is "*The concept of "waste" is eliminated by turning waste streams into a useful and valuable input to other productions and making better use of under-utilized capacity*" (Bocken et al., 2014, p. 49). Instead of minimizing the waste that is generated the firm seeks to create new values from their waste-streams or by-products and in that way create closed resource loops (Bocken et al., 2016). Ritala et al., (2017) further enhance the meaning of the archetype by renaming it from *create value from waste* to *closing resource loops*, aiming to describe the innovations that are reusing materials and products. By reusing the resources, the environmental impact the firms have will be reduced through decreased demand for new resources by exchanging it with waste streams from other industries (Bocken et al., 2014). In this context, re-design existing products or design new ones to extend the resource value are often mentioned (Bocken et al., 2014; Lewandowski, 2016). When making products that are easy to reuse, repair and recycle is central, it is in line the concept of the CBE (Reime et al., 2016; Hetemäki et al., 2017).

Examples of processes describing this sustainability archetype are Industrial symbiosis (IS) that aims to take waste from one industrial process into resources for another process or product line (Bocken et al., 2014). The concept known as Cradle-to-Cradle by McDonough & Braungart (2002 in Bocken et al., 2014) is also an example of initiatives from firms in line with the archetype. The concept is concerned with nutrient loops in firms, both closed loops and open-ended biological loops (Bocken et al., 2014). The open-ended loops are discussed because it can be difficult for firms to accomplice the closed loops, and materials from production can be released to the environment. In those cases, the waste-streams should not contribute to negative environmental impact, instead generating positive effects on the environment.

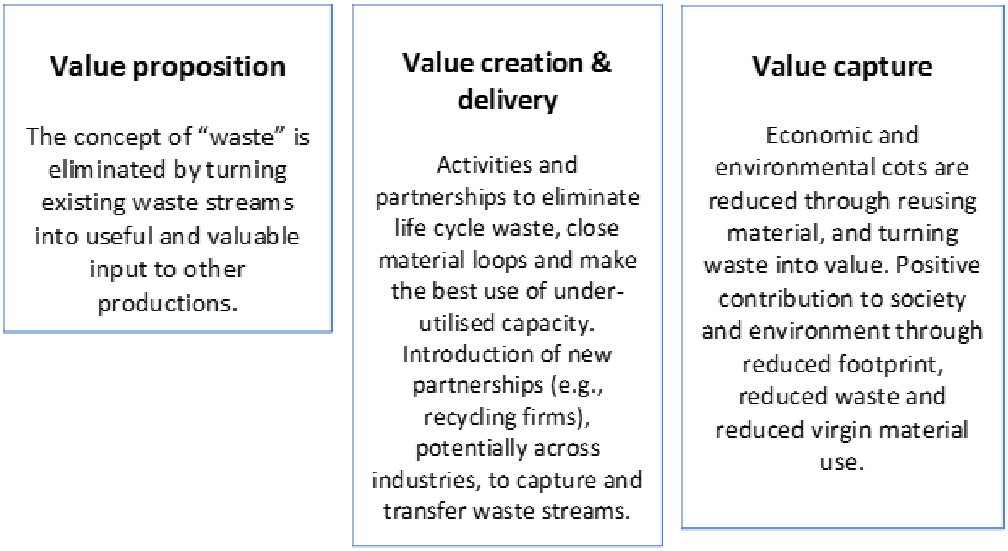

Figure 6. The value boxes of the archetype Create vale from "waste" (Bocken et al., 2014, own illustration).

The sustainable business archetype - Substitute with renewables and natural processes

The definition of the archetype is “*Reduce environmental impacts and increase business resilience by addressing resource constraints “limits to growth” associated with non-renewable resources and current production systems*” (Bocken et al., 2014, p. 50). Compared to the archetype *Maximise material and energy efficiency* and *Create value from waste*, which focuses in reducing environmental impact, this archetype is about exchanging the use of finite resources (e.g., fossil-based products, metals, chemical dyes), to renewable ones and in that way design-out negative environmental impacts. Therefore, this archetype is characterised by new technical solutions that deliver substitutes for the finite resources, as using the natural processes called bio-mimicry and green chemistry (Bocken et al., 2014). Further examples are the use of solar energy, new materials from bio-based fibre, such as wood. Several of these technologies exist however are not yet profitable or have not yet expanded to the volumes that are needed to gain efficiency. Nevertheless, in relation to the ongoing developments of technology and the legislation that are holding the innovations back, the opportunities for further development of new bio-based substitutes is prominent (Ritala et al., 2017). One issue that is relevant concerning this archetype is that when pushing for exchanging all finite resources with bio-based resources, new problems and sustainable obstacles can occur (Bocken et al., 2016). Bocken et al., (2014) gives the example of making biofuels that are produced by crops, which can be used for food or other essential products and questioned if it can be regarded as sustainable.

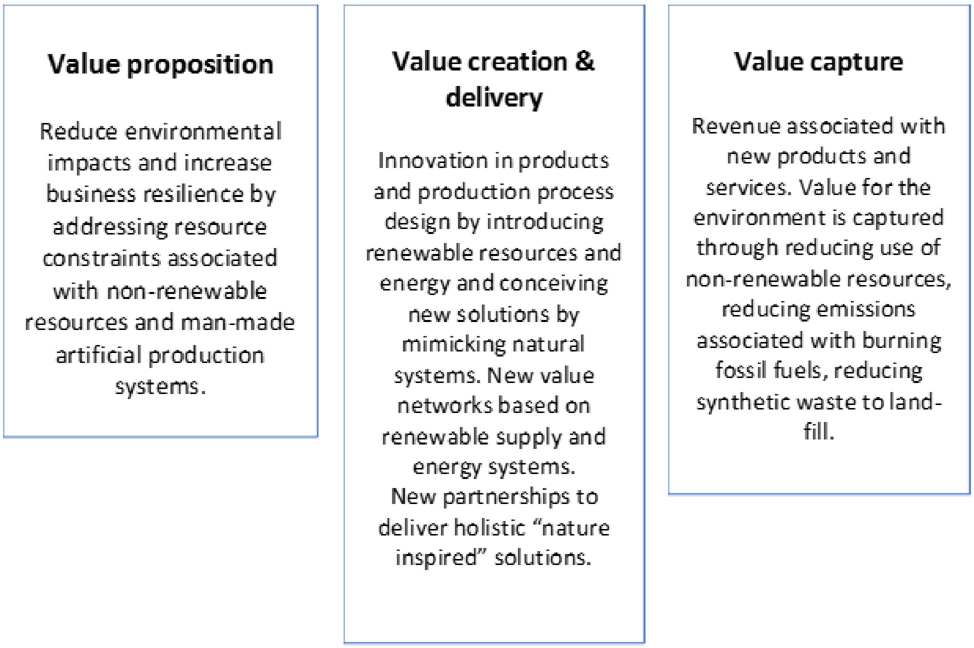

Figure 7. The value boxes of the archetype Substitute with renewables and natural processes (Bocken et al., 2014, own illustration).

Summary of SBMI archetypes

The SBMI represents the micro level perspective and to improve the integration of these SBMI archetypes (see table 5), collaboration with different actors, organisations, and sectors (e.g., different bio-based sectors) are highlighted. Collaboration is seen as a key to achieving many of the archetypes (e.g., one sectors waste, is another ones' resource) (Bocken et al., 2014; Antikainen & Valkokari, 2016).

Table 5. The technological group of sustainable business model innovation (Bocken et al., 2014).

Group	Archetype	Definitions
<u>SBMI</u> Technological/ environmentally orientated archetypes	*Maximize material and energy efficiency*	"Do more with fewer resources, generating less waste, emissions and pollution"
	Create value from "waste"	"The concept of "waste" is eliminated by turning waste streams into useful and valuable input to other production and making better use of under-utilized capacity."
	Substitute with renewables and natural processes	"Reduce environmental impacts and increase business resilience by addressing resource constraints "limits to growth" associated with non-renewable resources and current production systems."

Bocken et al., (2016) illustrate an example of a Sugar factory that has combined all three archetypes in the technological innovation group described above (see table 5). The sugar factory has extended their resource flow, and closed their own resource loops. Sugar is their primary business that results in different wastes and emissions. They changed their business model to create new profitable product lines from the waste and emissions of sugar production. For example, they use the excess heat and CO2 from sugar refining to grow tomatoes and heat the greenhouse. Another example is that they produce animal feed from a by-product of sugar refining and making bio-ethanol of other sugar by-products. It is an example of how a firm can close their material loop and what SBMI could lead into, helping the firm to stay competitive when a market is under stress.

3.4 Conceptual framework

The study is concerned with business model innovation for CBE with a particular focus on agro-aqua interactions and aims to assess what criteria that are needed for further development of aqua-agro interactions on Åland. The concept of CBE functions as the theoretical starting point of this study in trying to identify the criteria on a macro level perspective, which form the basis for SBMI to attain CBE developments.

The essential developments regarding the sustainability concept CBE are to change the current use of fossil-based products and materials and transform from the current linear value chains to circular ones. The concept addresses closing resource loops, and use the concept of cascading by-products and waste-streams, which is lengthening the value chains (Carus & Dammer, 2018; Stevens et al., 2018). In relation to aqua-agro interactions, it is the nutrient usage that is in focus for the interaction, motivated by resource scarcity and the increased environmental problems (Edwards, 1998; FAO, 2016). As promoted in the concept of CBE, by policymakers and governments, there is a need to transform the current systems of aquaculture and agriculture into more circular systems, finding new ways of handling nutrient and wastes (Edwards, 1998; FAO, 2000). Hence, the notion of closing resource loops is relevant also in the context of developing aqua-agro interactions. The concept of cascading emerged from the literature review of aqua-agro interactions. For example, the connection between the two sectors, aquaculture and agriculture can be to extract the nutrients from the seas by multi-trophic aquaculture and bring back the nutrient to the fields.

To be able to close resource loops and cascade bio-based waste and side-streams, the political and society support, the research and innovation and the rules and legislation that allows the transformation are highlighted (Allen, 2016). Further collaboration is proposed to be essential, both cross-sector between industries but also collaboration within research and innovation (Hetemäki et al., 2017). Collaboration, laws and regulations, political and society support, and research and innovation are regarded in the study as aspects promoted on a macro level to change the current linear and unsustainable system. These macro-level criteria identified from the literature reviews of the concept of CBE and aqua-agro interactions are illustrated in figure 8 and are used as analytical labels in the study to analyse and to help the researchers answer the research questions.

Figure 8. Analytical labels of CBE development (own illustration).

Furthermore, business model innovation is emerging in the literature reviews and stresses that a system change will require changes of current business models (Bocken et al., 2014; Bocken et al., 2016; Hetemäki et al., 2017). The innovation of current business models is regarded in the study as micro-level changes in a system perspective. In relation to the theory of SBMI, the production and process in firms practice are characterised by the waste management, the change from fossil-based resource usage to bio-based, and minimising the use of resources in general (Bocken et al., 2014). Therefore, the sustainable business model archetypes by Bocken et al. (2014), which is focusing on; m*aximize material and energy efficiency, create value from "waste", and substitute with renewables and natural processes* (see figure 9*)*, are added as analytical labels because they represents sustainable innovations identified in firms. Together with the analytical labels in figure 8, they serve the purpose to help the researcher analyse the results in the case study and help the researchers answer the research questions.

Figure 9. Analytical labels of SBMI archetypes (Bocken et al., 2014, own illustration).

The conceptual framework constructed in this study aims to identify criteria that are needed to develop CBE business models for aqua-agro interactions on Åland, the unit of analysis in the study. Figure 10 illustrates how the CBE concept on a macro level and the SBMI on the micro level is connected to the development of CBE business models for aqua-agro interactions. In this study, the macro level refers to ideas about CBE developments that are developed in policy, society and research. For example, individuals are affected by policy discourse. However, it is difficult for individuals to influence this discourse. Instead the individuals influence the micro level, for example, agriculture and aquaculture farmers are able to work towards more efficiency, new value creation and substitute resources (see figure 10). Simultaneously, there is an interplay between individuals (in firms), and ideas about CBE at a higher level of abstraction that has to be considered, e.g. inter sectoral working (collaboration), meaning, in this case, individuals in adjacent sectors have to collaborate. For example, laws and policy need to support and accommodate such collaborations, and research and innovation need interdisciplinary working to test and refine, to develop knowledge and capacity. Both the macro level and the micro level contributes to a system change, affecting the innovation of business models and shape the criteria for further development (see figure 10).

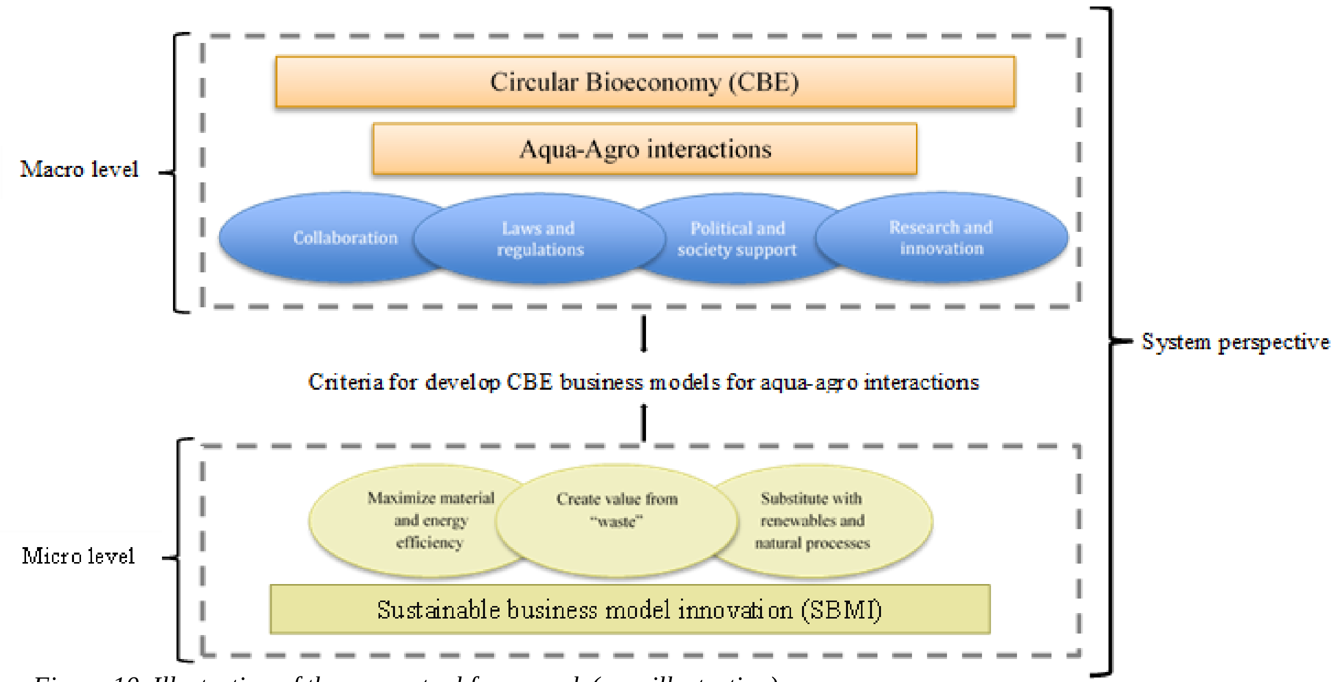

Figure 10. Illustration of the conceptual framework (own illustration).

4 Empirical data

In this chapter, the empirical result of the study is presented. The chapter aims to generate a description of the present situation on Åland through the actors' views with emphasis aqua-agro interactions on Åland. The picture generated will be analysed and discussed in following chapter in the attempt to critically assess what the criteria are that is characteristic for SBMI to attain more aqua-agro interactions on Åland.

4.1 The interviewees

The case study results is generated by semi-structured interviews with eight interviews that represent different instances that in different ways play a part in the aqua-agro interaction between actors on Åland. They were asked to generate examples and their views of the ongoing process on Åland to enable aqua-agro interactions. The following part of this section in the empirical chapter the interviewee's profession and role in the organisation are presented to enable an understanding of the different perspectives they represent.

4.1.1 The primary producers

Fish farmer

The aquaculture producer in this study is Sixten Sjöblom. He runs a company that is engaged in fish farming focusing on rainbow trout. He started the company together with his family in 1988. Then there were 32 fish farmers on Åland against four today in 2018. At first, he had four cages and produced 64 tonnes the first year. Today he produces about 500 tonnes of fish per year and is the smallest producer on Åland.

Dairy farmer

The agricultural producer in this study is Kristoffer Lundberg, runs a large dairy farm on Åland. He has approximately 300 cows and delivers the milk to the dairy on Åland and is one of the largest producers on the island. The regional government of Åland owns the land, and he is the tenant for the next 20 years. He does not have a family background in the sector and therefore when starting the company in 2012, he sold parts to a risk venture to reduce the risk when asked for finance by the bank. At the start, he had 160 cows, and since the milk crisis in 2015, he expanded the farm and doubled the number of cows. In parity to the milk production, he also runs a civil engineering contractor firm.

4.1.2 Producer associations

The Federation of Producers

The director of The Federation of Producers (*in Swedish: Ålands producentförbund*) Henry Lindström, represent the branch organisation of the agriculture and forestry industry, that can be compared to the Swedish Federation of Swedish Farmers (LRF) (Lindström, 2018). They work to ensure domestic food security by creating suitable conditions for farming, forestry, horticulture and other rural industries. Also, by presenting information and monitoring price and the support issues for the farmers and provide services like bookkeeping and declaration aid.

Ålands fish farming association

The director of Åland's fish farming association, (in Swedish: Ålands fiskodlarförening) Rosita Broström, represent the branch organisation for companies and associations engaged in aquaculture on Åland. The association work with promoting and develop the aquaculture industry on Åland, and improve the prerequisites for running the aquaculture business profitably. They also work as an information channel between companies, different authorities, and other stakeholders, and assist the members with assignments, advice and coordinate activities that concern the whole industry. For example, they worked with developing one of the five focus areas in the "Sustainable food strategy of Åland," the blue economy, and they are creating a joint communications strategy for the fish farmers at present (Broström, 2018).

4.1.3 The Regional Government of Åland

The Fisheries Section

The Fisheries section is part of the Department for Trade and Industry at the regional government of Åland and Jenny Eklund-Melander is Head of Fisheries Section. According to the Act on Autonomy Åland got legislative power in fishery and control of the fisheries sector and therefore the Åland government has the responsibility for implementing EU fisheries policy. Their responsibility includes monitoring of the industry, control of fishing quotas and maintaining registers related to the industry and provide financial support for the industry. They work with the local community, the industry, and the water managers, with fisheries issues, and they also manage the European Maritime and Fisheries Fund on Åland that provide support to industry and industry organisations, as well as pilot and innovation projects. The funds are applied by individual companies, e.g. fish farmers, fishers, processing companies, industry organisations and of research bodies.

The Agricultural Section

The Agricultural Section is part of the Department of Enterprise and Innovation at the regional government of Åland and Sölve Högman is Head of the section. The Agricultural Section is responsible for implementing the part of the agricultural policy that belongs to the responsibility under the self-government act (www, Ålandslanskapsregering, 2018). Since the entry in the EU, Åland is comparable to other member states (Högman, 2018) and the agricultural policies are still partly governed by the regional government of Åland. In practice, it means that the Agricultural Section handle issues about the rural development program, organic production, plant protection issues, import of plants to Åland, feed, fertilisers, seed, and support for replacement services. Högman (2018) explains that the activities in the Agricultural Section are comparable with the Swedish Board of Agriculture (*in Swedish Jordbruksverket*) and the County Administrative boards (*in Swedish: Länsstyrelserna)* in Sweden.

4.1.4 Other actors

Ålands rural enter

Lena Brenner also works at Department of Enterprise and Innovation at the regional government of Åland, but she does not work with agency issues. Instead, she works with rural development issues and the management of the rural centre on Åland (*in Swedish: Ålands landsbyggdscentrum*) and is involved in different projects related to the local food chain. For example, she has initiated the development of *the sustainable food strategy of Åland* as a result of a project aiming to identify the strengths in the food production on Åland. The food strategy has the purpose of creating a sustainable food brand that includes all of the food produced on Åland.

Ålands regional government venture capital Company.

Elina Lindroos is Managing Director of Investment Operations in Ålands Utvecklings Ab (ÅUAB). ÅUAB is Åland's regional government venture capital company that invests public funds in young unlisted companies related to Åland. ÅUAB and the sister company ÅFAB are described as active partners that help firms with advice and venture capital. Regarding both financing, constructions and business ideas. They aim to identify new and developable business areas that can contribute to the further development of Åland in the shape of company growth and increased employment, create export earnings and profitability.

4.2 The context of Åland

Åland is located geographically in the middle of the Baltic Sea between Finland and Sweden. Åland is characterised by its autonomy the Head of the Agricultural Section, Högman (2018) declares. In 1921 it was finalized by League of Nations (*Swedish: Nationernas Förbund*) that Åland should be a part of Finland instead of Sweden. In the processes, the people on Åland were given self-governance and promised to be able to continue to speak Swedish and keep their local customs and traditions. The self-governance has developed since then. Today it constitutes for example that Åland has a parliament, (*in Swedish: Ålands lagting*) that can enact laws in some specific areas, and they govern their business policy separate from Finland but do not cover the economic area in the way that Åland is not entitled to enact their tax regulation.

The Regional Government of Åland (*in Swedish: Ålands lanskapsregering*) is the executive authority in areas where Åland has self-government under the Self-Government Act. The government's political leadership consists of the National Council (*in Swedish: Lantrådet*) and six ministers. The regional Government of Åland is divided into different departments, and the departments are the divided into Sections (*in Swedish: byrå*). The Agricultural Section and the Fisheries Section together with the General Section and the Forestry Section constitutes the Business Department.

4.3 The agriculture and aquaculture sectors on Åland

Agriculture

The agricultural sector is described by Högman (2018), and it covers 14 000 hectares, of which approximately 50 % is grassland. The production consists of 30 % animal production and 70 % crops. The large part of crops is because of a favourable microclimate however noteworthy considering the significant part of grassland. The sector consists of approximately 450 farms, and about 50 % of those are full-time farmers, and there is a need in the sector for a generational shift. The sector turnover is 24 million euro, where approximately 30 dairy producers constitute a considerable part followed by meat, egg, and potato productions. However, Högman (2018) and the director of the Federation of producers, Lindström (2018) highlights that the profitability in the sector is lower than a couple of decades ago because of higher costs and no change in selling prices.

There is a variance in production on Åland, both in the type of production and in the productivity. Högman (2018) explain that a significant proportion of the sector is extensive farms, e.g. low productivity. Unfortunately, the extensive cultivation has grown on Åland, as there is an opportunity for subsidies in Finnish and European agricultural policy and there are those who have it as a business idea, to maximise their area support instead of having a profitable production. This is a system error, as there is a demand for farmland and products.

At the same time, some farmers are very productive and with a high technological gradient, for example, the apple production on the island (Högman, 2018). The apple production supply 70 % of the total supply of apples to Finland (Brenner, 2018). Another example describing the high level of export from the island is potatoes, which are processed to chips and supply entire Finland with potato chips, and 30 % of the onions consumed in Finland are from Åland. The sector also export milk to Finland and cheese to Sweden, and in regards to the export of meat, the lamb meat dominates.

The sector is often highlighted as a source of nutrient leakage to the sea and the source to environmental issues, which also the aquaculture sector is blamed for (Lindström, 2018). He adds that other sectors that have an environmental impact, as the shipping sector is not blamed in the same way. The dairy producers underline that for a farmer all leakage of nutrients is lost resources and affect the profit indirectly. The farmers always intend to use the right amount of nutrients and manage it in the best possible way.

Aquaculture

Aquaculture is the backbone of the fishing industry on Åland and Åland has a significant share of Finland's aquaculture production (40-50%) the Head of Fisheries section, Eklund-Melander (2018) explains. It is a vital business for Åland and especially for the archipelago. The industry approximately had a turnover of 37 million euros in 2017.

The technological developments in the industry are many and evolving quickly, the fish farmer, Sjöblom (2018) explains. When he started the production, he fed the fish by hand, compared to today where the feeding is automated. The technological transition is vital he stress, in the regards of future generations of fish farmers. They demand a different kind of lifestyle than the previous generations, looking for more solutions that improve the management and generate a more regular working hour. To be able to afford to evolve technologically it is crucial that the production volumes allow rising and making it possible to invest. Today the volumes are kept down by legislation and fish feed quotas.

The economic importance and the need for acceptance to evolve the sector is also explained by the Head of Fisheries section, Eklund- Melander (2018), by describing the situation on Åland, where there are 16 municipalities, and in the archipelago, it is difficult to get the economy going. However, the municipalities that have aquaculture look stable.

On Åland, there are four producers of fish that uses the method of marine net cages, and there is also a new RAS facility. The company is partly financed by the regional government on Åland, through the company ÅUAB (Lindroos, 2018; Sölve, 2018). The RAS company business concept is to grow premium rainbow trout in a modern, innovative and environmentally friendly manner (www, fifax, 2018). The company is controversial because during the start-up they unfortunately released uncleaned wastewater into the local environment (www, yle, 2017). The RAS facility does not either take part in the fish farmer association, which the Head of the fish farmer association, Broström (2018) explains is due to the significant difference in production compared to the traditional off-shore farming. Today the facility is up for sale before the construction is completed and before they have reached their production goals (www, yle, 2017).

The fish farming activities have historically been questioned on Åland (Sjöbom, 2018; Högman, 2018; Eklund-Melander, 2018; Broström, 2018). During the summer, the fish cages are located in the outer archipelago, and during the winter months, they are closer to land in the bays (Sjöblom, 2018). In the bays, they can have a negative effect in the inner waters because of the nutrient side-streams and fish residue accumulating on the bottom beneath the cages causing sedimentation. The local community did not appreciate it the fish farmer explains. Therefore, the local community did not eat any of the fish produced on Åland, which is the main reason that almost all fish generated on Åland is exported today to Finland. However, he sees changes in the mentality in people. The fish farming is not regarded as negatively as it used to be. The resistance emerged from the practice in fish farming in the earlier days (Broström, 2018; Eklund-Melander, 2018). The fish farming had a negative effect on the local environment. The primary cause was that the feed was not expensive and therefore sometimes overused and not as developed compared to today (Sjöbom, 2018; Broström, 2018).

4.4 The food strategy on Åland

Åland has a newly developed food strategy*, Åland's sustainable food strategy 2017-2030*, which was presented in January 2017. The food strategy takes off from the sustainability perspective, and throughout the strategy, there is a red thread linked to climate issues and future adaptation (Wiklund, 2017). The food strategy is promoting circular economy, and the aim is not to create circularity in every firm itself. Instead, the food strategy is aiming for a system approach on Åland creating not just circular loops in regards of resources in firms, but also closing the loops together with several actors on Åland (Wiklund, 2018). The strategy also aims to help Åland create a sustainable food production that will generate a strong marketing brand for the food chains on Åland and helps separate the products from the regular low-price products (Brenner, 2018; Lindström, 2018). The Federation of producers has been one of them who initiated the work with the food strategy together with Lena Brenner, at Ålands rural centre (Lindström, 2018).

Brenner (2018) explain that by focusing on re-circulating the nutrients on Åland, the aim is that Åland will import fewer nutrients from elsewhere. Instead, they should increase the locally produced nutrients and be more self-sufficient. To be able to build a brand where Åland is regarded as a more sustainable choice, which the consumer and society is demanding, there will be possible to request a higher price and get paid for the activities the food producers do on Åland to be the most sustainable option. The consumer plays a vital part in the transition Broström (2018) stresses. They need to understand and appreciate the initiatives in the food production, which will lead to higher demand for products from Åland. Brenner (2018) adds the need to educate the consumers which food production can be regarded as climate-friendly. To achieve this change in the system the strategy attaches great importance to the requisite for attitudes and behaviour changes from all actors, agencies, firms, and individuals (Wiklund, 2017). The mindset needs to be more favourable towards change, and the behaviour needs to be more proactive, inclusive and engaging and not only react when crises come true.

The food strategy defines five "Spearheads" (*in Swedish: spjutspetsar*) which represent areas where Åland has the opportunity to position themselves to achieve their goals and increased competitiveness. There is Industrial symbiosis around the circulation of nutrient, Circular blue economy, Improving soil health, Biodiversity, living landscapes and grazing animals, and Gastronomic island worth visiting (Wiklund, 2017). Broström (2018) tells that the fish farmer association and the fish farmers been active in the making of the spearhead, Circular blue economy, and say that they will try to continue the work while the discussions are ongoing.

One element that is holding the development back in relation to the agricultural sector may be that the agricultural advisory organisations are not onboard regarding the implementation of the strategy (Lindström, 2018). The dairy producer, Lundberg (2018), comment that the agricultural farmer's participation in the implementation of the strategy to be very poor, which also Lindroos (2018) stresses. For Lundberg (2018) it has been interesting. However, he says it is sad that the farmers not have been interested and he believes that a reason could be that they were hoping the food strategy would generate a simple solution within a shorter timeframe. The concept of circular economy is too grand and complicated for many. The timescale is also discouraging many because the required investments will be profitable first when the farmer is ready for pension. He stresses that it had been positive for the agricultural sector if they got better in telling that they are taking care of the resources and tried to erase the picture that the agricultural production is environmentally dangerous, and at the same time create new values to capture.

4.5 Aqua-agro interactions on Åland

The interviewees had difficulties to find an example of existing aqua-agro interactions on Åland, as in two primary sectors collaborating to achieve higher sustainability in their productions. The managing director of investment operation in ÅUAB, Lindroos (2018) say that there are several projects in progress on a smaller scale, but unfortunately, they have to be unmentioned. She only adds that such projects can be inspiration sources for others to build own productions. However, she mentions that there is one horticulture farmer that has developed an own small aquaponic system. Developing aqua-agro interactions are promoted because it could generate new values for the sectors (Broström, 2018). It will also contribute in regards to social aspects, e.g., employment in the archipelago (Broström, 2018; Eklund-Melander, 2018; Lindroos, 2018).

4.5.1 Collaborations

The interviewees give several views of the concept of aqua-agro interactions. Högman (2018), the Head of Agricultural Section does not think aqua-agro interactions as diversification of a farm is the most efficient way of developing the production. He mentions the production he has seen, the fish production is minimal, and he considers it to be a push for innovations that help people think in new ways. Instead, he believes that the idea of having a land-based fish production where the nutrient-rich waste stream is brought back to the fields is a better example of creating aqua-agro interactions. That kind of interactions would be very positive for the environment (Högman, 2018).

The fish farmer in the study, Sjöblom (2018), explain that it is difficult to achieve aqua-agro interactions because at the moment there is no understanding of what problems agriculture is facing. Therefore, it is hard to look for mutual solutions. Agriculture goes its way, and the aquaculture goes their way (Lindström, 2018; Lindroos, 2018; Sjöblom, 2018; Lundberg, 2018). In the past, the two sectors have been more like cats and dogs, blaming each other for the environmental effects shown in the ocean, as eutrophication (Sjöblom, 2018). Eklund-Melander (2018) mean that it is essential to find a consensus about the circulation of nutrition and go beyond today's approach of considering the own company and sector. The fish farmers are more positive to this type of thinking, but it is difficult to get the agricultural farmers to rely on it (Lindroos, 2018). Lindroos (2018) stresses the need for co-ordinate to find these mutual solutions. It is needed to see that each other exists to increase the consensus between the sectors and it would be preferable to open up a collaboration where they present their problems and what is needed to do and from there, discuss how to help each other and find these interactive solutions (Lindroos, 2018).

The primary producers could be able to collaborate (Eklund-Melander, 2018). However, the question if the prerequisites for realising the goals is given. It requires the acceptance regarding that the nutrients have to be able to circulate. Today's linear systems do not fit into the new way of thinking, and it is hard to rebuild the systems step by step (Broström, 2018). Even though it is hard to find mutual solutions, all the interviewees mentioned that there is a willingness to find these solutions and make use of the side-streams as much as possible. Lindroos (2018) believes that achieving collaboration need to involve local associations to drive the two sectors closer because of their knowledge about what the primary producers want. She also adds that it is vital to continue the work now when the question is relevant, however these kinds of activities are expensive to administrate.

Today, the sectors are more collective than before (Sjöblom, 2018). One reason he stresses is that they are both sectors that are active on the countryside, which he emphasises is significantly affected by the ongoing urbanisation at the moment, because of depopulation which in turn is created by the lack of employment and public service (Sjöblom, 2018). To survive in the countryside, collaboration is needed he stresses. The responsibility to increase the collaboration is not just the firms' responsibility, neither the regional government, it is instead many pieces that have to fall into place (Brenner, 2018; Broström, 2018). Sjöblom (2018) stresses that the firms must participate although the profitability is strained, and the firms need to stay within the profitability to survive, which inhibits to adopt a new way of thinking.

A collaboration between aquaculture and agriculture could be purely economic the Head of the Fish farmer association, Broström (2018) stresses. Through compensations activities such as a fish farmer bear the cost of an operation that lowers the nutrients leakage to the water from the agricultural farm. The fish farmer could in return be able to benefit from with a specific increase in production volume. The Head of Fisheries Section agrees. If the food sector was allowed to use the nutrient cycle more innovative, it had added value for aquaculture and the environment (Broström, 2018; Eklund-Melander, 2018). Another example could be if the fish farmers funded activities in the inner-waters and in return was allowed to produce more in the outer sea. In that way, steps to achieve a good ecological status in the inner areas would be reached, which there is no current funding for.

4.5.2 Laws and regulations

The laws and regulations affect both sectors, and Eklund-Melander (2018) and Broström (2018) gives an aquaculture perspective. The limitations for the aquaculture is the environmental issues, and it is difficult to get new permits for production because it entails nutrient emissions that may add to the eutrophication of the Baltic Sea. It is both the local water law on Åland and the EU directives that are interpreted very strictly, not allowing any new permits or change activities in aquaculture production in the Baltic Sea (Eklund-Melander, 2018; Broström, 2018). The Fisheries Section and the fish farmer association are always looking, together with the fish farmers, after innovative ways to make use of nutrients and gain nutrient circulation. For example, they look at the possibilities to use fish from the Baltic Sea as a raw material in feed. In this way, they aim to create a cycle-based feed by taking nutrient from the Baltic Sea, instead of importing it and add to further eutrophication.

The amount of nutrient taken from the Baltic Sea is then allowed to be brought back as nutrient emissions from the fish production, a fish production that is more sustainable for the Baltic Sea. To develop this kind of ideas are difficult because of the very strict interpretations of the EU directives and the local water law, but also because of the environmental side in politics, which is critical. Lindroos (2018) also stresses that laws and regulation in many ways have a negative impact on innovation. Getting a consensus Eklund-Melander (2018) stresses has been difficult. There is a need to reprocess the legislation to reach a consensus and define what cycles that is permitted.

Broström (2018) continues and expresses there are mixed signals from the EU. The aquaculture should increase, then at the same time, it is made impossible by other directives that cannot be reconciled. The question should instead be; how much food do we need to produce? Moreover, how will we provide it? To be able to answer the final question the aquaculture would be highlighted because it is an excellent way to generate climate-smart and healthy food. She also emphasises that it is expected from the political perspective that all problems will be solved by one solution, right away. However, the reality is impossible to move forward if not allowed to take on step at the time.

One effect that has an impact on the agricultural sector in relation to laws is the RAS production facility that has been in contact with farmers to be able to sell their residues from filtering the water in the fish tanks (Lindström, 2018). The Federation of producers has advised the farmers not to use the residues before the agencies clear it. The same reason that the agriculture is not using the sewage sludge as fertilisers because of the risk of unknown substances. For example, it may contain drug residues in the sewage sludge (Brenner, 2018).

4.5.3 Political and society support

The political aspects are brought up by several of the interviewees when asked what different organisations role is to promote aqua-agro interactions. On Åland, there is a strong environmental side, however there is no representative for the companies because the enterprise and environmental minister is the same person, the fish farmer stresses. Högman (2018) mention that the minister of enterprise and environment calls herself Sustainability Minister when explaining the political governess of the regional government of Åland. The fish farmer, Sjöblom (2018), say that in this way there is no counterpart and therefore, no discussions taking place which makes it impossible to find solutions. Because of the situation, the aquaculture sector sees it as their voice is never heard and that they never get their message out. The message that the sectors need to be allowed to develop their productions if they are going to still exist. Broström (2018) also mentions the lack of understanding from politicians regarding the aquaculture sector. The sector does not miss the production sites nor the knowledge, just the permissions to produce, she explains, and Eklund-Melander (2018) agree that there is little room for development. One example, describing the situation is the use ratio of emission per capita in the discussion between the sector and politicians regarding the fish production on Åland. The politicians say that Åland cannot complain about other countries emissions to the Baltic Sea when being worst in class (Broström, 2018). Broström (2018) and Eklund-Melander (2018) explain that this relation is irrelevant. Eklund-Melander (2018) clarifies that when having a population of 28 000 - 29 000 people and supplying the yearly fish consumption of hundreds of thousands of Finnish people, the emission per capita from the aquaculture on Åland is high in relation to the local population. Broström (2018) add that kind of ratio is relevant when measuring emissions that increase when population raises. So, she usually asks politicians that if the population doubled on Åland, the emissions from aquaculture would be reduced by half?

In the agricultural sector, the political system is discussed in another light, not as an opponent of the sector. Instead, they emphasise the uncertainty in the political system that affects the development. The problem in the current EU-system of subsidies for agriculture is mentioned by Lindroos (2018). There are only 1-year support, and it is no one that knows if there will be subsidies ten years from now and add that the sectors need to believe in their business idea without the support system. Perhaps, the development of concepts as CBE and aqua-agro interactions may help the producers build up a market that is more stable in the sense that they are involved in several steps in the value chain, she said. The milk producer, Lundberg (2018) also mention that the political system is affecting the investments. He implie that the four-year term of office is a short time in comparison to the 15-20-year payback time the investments requires. Therefore, investments that are based partly on political willingness is hard to motivate when searching for finance, and then it should be a very safe investment if the banks should grant a loan. That may also be the reason that the existing investments often are related to energy, like biogas because it is possible to find the figures and show the bank the investment calculations.

4.5.4 Research and innovations

There is interest in the primary industry to be more sustainable, however it needs to come in commercial form, to be able to calculate and manage (Högman, 2018). The innovations have to be realistic and not too costly, otherwise they will not be realised. There must be an economy, and then there may be changes in the right direction. At the same time, innovation and development are needed, yet Åland will not develop these. Åland can be a test platform and thus get a lift in the right direction. Right now, the main focus is to find alternative sources of energy, e.g. the discussions about the biogas plant (Lindroos, 2018; Högman, 2018).

In the context of aqua-agro interactions in a broader perspective, Broström (2018) and Högman (2018) thinks it had been interesting to retrieve the bottom sediment from the sea to the fields again although explain that technological innovations are required. Högman (2018) further tells that it has been projects, however it takes time and money to get these solutions in commercial form. They must also be reasonable from an economic perspective, and Sjöblom (2018) explains that picking up something from the water costs about 50 times more than picking it up on land. Broström (2018) describes that it is a lack of concrete solutions in general and the solutions available are not developed. It is a cost issue, and the existing methods are not economically viable at the moment (Brenner, 2018). It still requires research and development and then it needs volumes to dare invest which makes it challenging to address (Broström, 2018). Lundberg (2018) describes that Åland is not a perfect place to try out newly developed innovations because of the distance from the inventory, service, etcetera, which may require the actors to focus on more simple technical solutions. He gives the example of new energy solutions and implies that the energy is too cheap in relation to the amount of money that is required for investing. All the interviewees agree that they will find solutions in the future, but it is about taking small steps forward stresses Brenner (2018). Lundberg (2018) describes innovations as; "If it not exist, there will not be any demand for it. The producers have to get started before the demand can be created".

Ongoing research and innovations on Åland

Biogas plant

In relation to the food strategy on Åland, development of biogas plant is highlighted. There are two biogas plants on Åland that belongs to two companies in the food processing industry. However, there is a discussion about making a large biogas plant for the whole of Åland to take care of, for example, household waste and slaughter waste (Högman, 2018). Though there is a problem with the hygiene criteria, to reach 70 degrees Celsius in the process (Högman, 2018) and the process gets very complicated when mixing different inputs (Eklund-Melander, 2018; Lundberg, 2018). The Agricultural Section is involved in the discussion based on the interest in making an organic fertiliser that can be spread on the fields again (Högman, 2018). The intention is to decrease the use of fertiliser and mean that the organic fertiliser from the biogas plant smells less, which will reduce the community impact during spreading periods. Though, the price of fertiliser is still too low that it is not economically viable in the same way to decrease the usage and buy organic fertiliser instead (Lindström, 2018). Lundberg (2018) mean that it is vital to show that they are taken care of their residues in the production. Broström (2018) consider that biogas is the last thing you should do in the value chain and implies that there is often another product with a higher value that can be made before it ends up in the biogas plant. In addition, it requires very high investments, which reduces the number firms that have the potential (Lundberg, 2018). A dairy farm with 30 cows has not the potential to build a biogas plant itself. Instead, several farms have to collaborate which requires closeness and so on. Therefore, the larger farms have more ability to invest in a biogas plant and on its own create circulation. Högman (2018) mean that it is a significant gap in current cycles when the compost is not returned to the agricultural fields, and the biogas plant is a step towards filling that gap. Even though there is a willingness to be more sustainable, it is not shown in the legislation (Lundberg, 2018) and gives an example of the ferries that byes cheaper fuel in relation to the biogas due to the taxation.

Fish oil and fish meal

A present project is to find a higher usage of the by-products from the fish production (e.g., the fish discards from the slaughter and dead fishes). Today, the dead fishes go to compost, and the fish discards are sent to mink farms or fox farms. The ongoing project involves starting a joint venture with the other fish farmers on Åland and a local development company. The plan is that they will extract the oil from the fish discards and make a fish meal of the other residue. The new products, fish oil, and the fish meal will be sold as components to the fish feed industries. Later the fish farmers buy their feed from the industry, and in this way, they can get a cycle and motivate that they are using a cycle-based feed. The fish farmer stresses that all fish farmers have to join. Otherwise, they will not have enough volumes to have a profitable production or be interesting to collaborate with for the large companies in the fish feed industry. The positive aspects of creating the joint venture are not principally adding to the company's profit, because it will not generate any considerable money (Sjöblom, 2018). Instead, it is highlighted as a way of strengthening their image. The fish farmer explains that by being able to show and to say to consumers that the fish producers on Åland can be part in creating their fish feed, he believes it is positive and in line with what consumers are requesting from the industry today. He adds that the challenge is also to keep all parts in the joint venture happy otherwise everything can fail.

Fish diesel and mussel project
Before this project, the fish farmer Sjöblom (2018) tells he used the fish oil to create bio-diesel. The diesel he has used in the firm's transports, and also the public bus traffic in Mariehamn also used the “fish-diesel.” However, because of the taxations, that are as high as for fossil-based fuel, the production is not profitable, and he will not continue. He stresses that the legislation is not promoting such innovations yet, although it generated some positive publicity that he believes is useful for turning the negative historical image about the aquaculture to a more positive.

Another project that he has been involved in is a mussel-project, an example of multitrophic aquaculture that makes use of the nutrient released in the fish production, which can later be used as a recycle-feed. This project was one of several hands-on suggestions in the food strategy of projects that are relevant for the implementation of the strategy (Wiklund, 2017). The conclusion was that the production was not profitable when the competition on the market is so hard, because the mussels grew to slow and became small because of the brackish water. Sjöblom (2018) said that the technology exists, at least in experimental forms, to process the mussels so they can be used for example in feed for egg production, but he believed that the regulations were keeping such projects back.

5 Analysis and discussion

This chapter aims to address the results from the previous empirical chapter by analysing the results using the conceptual framework from chapter three. The chapter is structured by describing the aqua-agro interactions in the context of Åland, which is analysed out of the analytical labels in the conceptual framework generated from the literature reviews, and discussed and later the three technological sustainability business model archetypes by Bocken et al., (2014) and the empirical results are analysed and discussed.

5.1 Analysis and discussion of Aqua-agro interactions on Åland

The concept of CBE is described as new and growing (Reime et al., 2016), whereas the aqua-agro interactions are divided in having a long historical background (FAO, 2000), and having a newer high technological developments (e.g., aquaponics in RAS-facilities and multi-trophic productions) (Graber & Junge, 2009). Our case study research shows that the aqua-agro interaction is not something that is already established on Åland. The only example highlighted in the empirical findings is a small aquaponic farm. However, there is no lack of the potential for aqua-agro interactions on Åland. One example is that the residue from the RAS production facility on Åland can be used as organic fertiliser. However, as the literature stressed, there is a current struggle to make profitability in these new high technology systems (FAO, 2016; Rakocy et al., 2006; Somerville et al., 2014), which also is shown on Åland. To develop the RAS facility to an aquaponic, i.e., add a horticultural production to make use of the nutrient on sight was not mentioned in the interviews.

In the next section in this chapter, the analytical labels from the macro level perspective in the conceptual framework is analysed and discussed; *Collaboration, laws and regulations, political and society support, and research and innovation (see figure 8).*

5.1.1 Collaboration

Collaboration within and between different sectors are highlighted by researchers and policymakers to be important in the transition to a more CBE development (Allen, 2016; Bezama, 2016; Reime et al., 2016). Aqua-agro interactions can be diversifying a farm or collaborating with different sectors (Carus & Dammer, 2018; Little & Edwards, 2003). To collaborate between the aquaculture and the agriculture sectors, the primary producers in the study found it to be difficult because the lack of knowledge of each other's businesses and therefore do not recognise the opportunities. They also highlight the difficulties in finding a partner to collaborate with that have the same willingness and ability. To be able to see the possibilities in relation to aqua-agro interactions, the need for coordination of the actors in the different sectors was highlighted, which will help the actor to find each other and make a starting point for collaboration. One interviewee stresses that the activity needs a local organisation or person to drive the coordination.

Carus & Dammer (2018) mean that the regional conditions shape which sectors that will have the ambitions to do the CBE activities. The conditions mentioned are the natural resources, the local supply and demand, and infrastructure. The aquaculture sector and the agriculture sector face many similarities, but also differences. For example, the case study research shows that the aquaculture and agriculture sectors share the same conditions for infrastructure, baring costs of transportation because they are located on an island. They in some regards also share the feeling of being blamed for the environmental issue of the local eutrophication, which also can be an example of a regional condition.

The collaboration between actors will help the concept of CBE to go “from niche to norm” (Hetemäki et al., 2017). The actors that play a part in developing such interactions are primary producers, processors, consumers, associations, public media, agencies on Åland. However, there are also actors outside of Åland that play a part, for example the fish feed industry in Finland and the national laws of taxation in Finland (the area where the self-government act not rules). The variety and number of actors indicates the complexity of collaborating, many actors need to find their way of acting to change if a system-change will occur. Though, it is mentioned that if there are too many stakeholders in a project, the issue that no one wants to take more responsibility than others can arise.

Bocken et al., (2014) explain that the value capturing is also the positive contribution to society and through the reduced environmental footprint. One example from the empirical results is that the interviewees from the aquaculture sector stresses that a collaboration between the sectors does not need to involve the nutrient flows. Instead, they say that it could be financial collaborations. To be able to produce more fish, the fish farmer can help finance an activity that reduces the nutrient leakage from the fields, or it could be other activities. It creates a zero-sum outcome. However, it could be argued that the environmental footprint can be reduced in a global perspective, lowering the transports by the decreased import of fish. The collaborations in the literature review are not highlighting the possibilities of financial collaborations. Instead, the focus is on resource exchange between sectors.

5.1.2 Laws and regulations

A further issue that is discussed when promoting CBE development is the legal framework (Carus & Dammer, 2018). The framework that regulates the use of biomasses need to be in line with the cascading principle. The interviewees have stressed that the legal framework inhibits some initiatives, such as using the residue from the land-based fish farm on the fields because they do not know what the authorities will say. From an investor perspective and the aquaculture sector, they express that the legal framework is limiting innovations at the moment. In the literature review, the www, ec.europa (2018) shows a willingness to promote closed resource loops and proposes changes to the legislation to enable such innovations. The opposite impression is given by the aquaculture representatives that stresses that the EU gives mixed signals and the directives are often counterproductive.

5.1.3 Political and society support

Allen (2016) argue that improved stakeholder engagement, policy interaction, and development of markets in the bio-economy and the circular economy will be needed in the transition. In the case study results, building a brand where Åland is regarded as a more sustainable choice, which the society is demanding will generate the possibility to request a higher price and get paid for the activities the food producers do on Åland. They argue that the consumer plays a vital part in the transition and needs to understand and appreciate the actions in the food production, which will lead to higher demand for products from Åland. They also add that education of the consumers of climate-friendly choices would be a positive action to do. That the consumers play a significant part in the adoption of a new concept is highlighted by Allen (2016). He explains that consumers need to be a part of closing the loop by using the services as recycling the products they are using and in the first place choose the products and materials that are promoted.

Policy-makers are highlighting the CBE as an important concept for sustainability (Allen, 2016; Hetemäki et al., 2017) and policymaking is also regarded as having a vital role in the transition to more CBE innovations. The development of long-term strategies is stressed by

Hetemäki et al., (2017) as essential. Concerning the case study results, the political willingness is expressed by the newly developed food strategy on Åland, and several of the interviewees highlight the political importance. The aquaculture sector is searching for a consensus between the politicians and the sector, stressing the lack of understanding that innovation processes takes small steps one at a time on the road to sustainability. The agricultural sector discusses the political timeframes, meaning that the innovations payback time is 10-20 years and it is hard to forecast the political will in the future. The food strategy on Åland is reaching to the year 2030, which is shorter than many of the innovations payback time. Also, the subsidy system for the agricultural sector has a one-year time frame, which is stressed to affect the willingness to make more substantial investments.

5.1.4 Research and innovation

Even if there are regional differences, there is a need for international collaboration of activities and innovation centre (Reime et al., 2016). Several of the interviewees agree with this statement and tries to be a part of as much research projects as possible. www, FAO (2017) promotes innovation within IAA system, and the factors that are highlighted are the need for supporting farming technology and management practices to be able to scale up the business models. Before-mentioned innovations are in line with the case study results that shows that there are several ongoing innovations on Åland, however some of them are not economically viable at the moment. One of the interviewees argued that the innovations has come before the demand and economic viability can arise, and gave the following quote;

"*If it not exist, there will not be any demand for it. You have to get started before the demand can be created*" (Lundberg, 2018).

Transitioning to the CBE concept can lead to more sustainable resource use at a lower cost while developing new income streams (Allen, 2017; Keegan et al., 2013). The empirical findings are that there is a willingness to create innovations and activities in the primary sector that is regarded to be in line with the CBE concept, such as cascading. Cascading is described as a mechanism to maximise the effective use of bio-based resources by prioritising making materials and products instead of using biomass as an energy source (Mair & Stern, 2017).

5.2 Analysis and discussion of technological SBMI archetypes

In this section of the chapter, the analytical labels from the micro level perspective in the conceptual framework is analysed and discussed; *maximize material and energy efficiency, create value from "waste", and substitute with renewables and natural processes (see figure 9).*

5.2.1 Maximize material and energy efficiency

The archetype is about minimising waste and reduces resource demand by handling the resources more effective (Bocken et al. 2014). The dairy producer and the fish farmer do not intend to minimise waste. Instead, the focus is to maximise their material and energy efficiency within their firms. The dairy producer stresses that a nutrient leakage is a lost resource which results in higher costs and the fish farmer emphasises that no fish farmer do not ineffectively manage the fish feed today.

The motivation for maximising the material and energy use is to lower the total consumption of resources in the system and in that way be more sustainable (Bocken et al. 2014). The initial motivation for maximising the efficiency in the case of the primary producers in the study is not to minimise their impact on the environment nor the society. Instead, the profit is highlighted in first hand due to strained profitability in the sectors. At the same time, profitable aquaculture and agricultural producers are discussed in the sense that they generate the ability to keep employment and infrastructure on the countryside, which can be regarded as a social aspect. The social aspect is also highlighted as one of the fundaments by the interviewees for collaboration between the sectors and developing the sectors. Both aquaculture and agriculture are active on the countryside and face the similar problems (e.g., less public functions). The positive effects in regard of the social aspects are opposite to the theoretical reasoning by Ashford et al., (2012 in Bocken et al. 2014) that instead say that the archetype can generate unemployment because of the improved productivity and efficiency.

The archetype *Maximise material and energy efficiency* is described to have a technical innovation part that is transforming the business model from commercial to sustainable (Bocken et al. 2014). The study implies that the aquaculture and agricultural producers on Åland are aiming to be more resource efficient in a commercial way, as changing production activities to generate profit. However, the indirect consequences are compatible with the sustainable aspects, as the environment and social benefits are gained by the suggested activities.

It is possible to divide the field of BM into conventional and sustainable ones (Neumeyer & Santos, 2018). Bocken et al. (2014) describe the intention of being more resource efficient in the conventional initiative is to create lower production costs and offer a better price for the consumers. Out of the case study results, the aim is instead to capture a higher price because of the changes in production. The interviewees tell that the intention of the food strategy is to create together a more sustainable Åland, advertised through a united brand that will generate higher revenues for the producers and processors. The fish farmers say that the aquaculture sector needs to take part in projects and be more innovative to improve their image with consumers. The dairy producer believes that there are many opportunities that can be realised if the sector got better in telling how they produce for the society.

5.2.2 Create value from “waste”/ Closing resource loops

Compared to the previously analysed and discussed sustainability archetype, this archetype is not focusing on innovations that reduce the waste in the production. Instead, the innovations are related to making new values of waste-streams in the production, a way of reusing the materials (Bocken et al., 2014). The fish diesel described in the case study results is an example of processing the waste, in this case, the discard from fish slaughter to a new product. The reason the production stopped is that the taxation is the same as for other fuels and the production was too small and expensive to be able to make a profit. Instead, the fish farmer explores other alternatives, which is the new joint venture between the fish producers on Åland. To create partnerships is one example of value creation activity in relation to this archetype (Bocken et al., 2014). Their discard will be turned into fish oil and fish meal that will be sold as components to the fish feed industry. He stresses that they have to collaborate, otherwise they do not have the sufficient volumes. The underlying reason for the development of this new products is to be able to promote that they are closing the nutrient loop by creating components for fish feed, a input that they buy from the fish feed industry and therefore can promote their production to be more circular and sustainable. Making components to fish feed is also an example of up-cycling, where the waste becomes a valuable resource and is not only used as an energy source in first hand (Keegan et al., 2013; Mair & Stern, 2017).

These innovations in this archetype are also expressed as synonymously with closing loops (Bocken et al., 2016; Ritala., 2017) and current trends in aquaculture research are to find possible ways of bringing back the nutrient leakage by creating loops (Frostell, 2015). In relation to closing the loop in aqua-agro interactions on Åland, meaning that resources (e.g., nutrients) are circulated between sectors, several mentions bringing back the sediment from the sea. They mean that if the sediment from the bottom of the inner water could be brought up, it had been very positive, however they are far from seeing it today in a commercial form because of the high costs and lack of technology.

It is stressed by Bocken et al., (2014) that by using waste as a resource, the demand for new resources will decrease. The same motive is expressed by the underlying initiatives of the food strategy where the import of nutrients to the island ought to decrease if they could come up with innovations that used the resources on the island in a circular way.

The CBE concept is promoting cascading of bio-based resources. The results from the case study suggest that the aquaculture sector is closer to cascading as there is a high value in feed components and it can be profitable to extend the chain. The motivation is also associated with obtaining solutions that ultimately generate the opportunity to produce more because a reduced negative impact in the Baltic Sea could, in the long run, mean added permits. While agricultural sector does not push cascading innovations in the same sense, the reason could be that the fertiliser is still regarded as cheap or, the technology that is required to, for example, make a "refined" organic fertiliser is still too expensive.

5.2.3 Substitute with renewables and natural processes

This archetype is characterised by new technical solutions that deliver substitutes for the finite resources (Bocken et al., 2014). Compared to the other two technological archetypes analysed and discussed above this archetype is focusing on designing out the environmental impact by innovations that replace fossil-based material in the production of bio-based materials. Hence, this is in line with the characteristics in the definition of BE which is to produce, for example, food, feed, materials, products, and energy, included waste and by-products, from renewable biological resources from land and sea (Cavallo & Gerussi, 2015; Carus & Dammer, 2018; Keegan et al. 2013).

The interviewees that are representing the agricultural sector present examples related to this archetype, for example the biogas plants on Åland. Today, the majority of the discards are burned up (e.g., discards from the meat industry) or goes to compost (e.g., dead fish and horticulture discards), and by using a biogas plant to take care of these discards, new values as energy and organic fertiliser are created. By using the organic discards from several actors (e.g., the agricultural and aquaculture productions and the consumer waste) some of the nutrients that were taken away can be brought back on the agricultural fields. The biogas plant is mentioned as one way to decrease the need of using fertilisers and decrease the demand for breaking new finite resources as phosphor. In the same context, the innovations are slowed down by the low energy-prices making it hard to motivate the investments.

It is also mentioned by one interviewee, that by seperating the nutrients in the organic fertiliser, a higher resource efficiency could be gained, as the potato producer need more phosphor and the dairy producer need more nitrogen on the fields. Three of the interviewees stress that technology is essential for these innovations although is held back because fertiliser is too cheap to buy at the present, which do not motivate such initiative. Bocken et al., (2014) mean that SBMI may not be economic defensible at the beginning, however stresses that many new green inventions are not.

6 Conclusions

This chapter aims to explain what the findings in the study conclude from the preceding chapters, and answer the research question stated in chapter one: What are the criteria that form the basis for business model innovation to attain CBE developments? What are the relevant criteria for developing circular bio-economy business models with emphasis on aqua-agro interactions on Åland.

6.1 Findings and contributions

The literature review revealed that the concept of cascading bio-based resources and closing resource loops are appropriate concepts to promote business model innovation for CBE development. The relevant criteria to develop business model innovation in line with these concepts was collaboration, such as inter sectoral working (e.g. firms, industry, agencies), as well as inter disciplinary working (e.g. research disciplines). Further, a legal framework that allows innovations, a willingness from the policy makers and society and the high need for more research and innovation. The case study results also strengthen these criteria.

The theory of SBMI used in this study addresses the sustainability innovations in a technical way referring to that the developments are oriented around technical flows and interactions that allow resource flows to be identified and measured. The aqua-agro interactions technical parts can be placed in the SBMI archetypes (e.g., cascading and closing resource loops). For example, the technical innovations found in the case study results focused on the development of new biogas plant, solutions for commercialising organic residues. However, in this case study, the findings are that the technical innovations are affected by the social interactions between firms (e.g., the collaboration partners), however also by the social interactions in a society. This study shows aspects of this complex reality of developing aqua-agro interactions with particular focus on SBMI.

Further, this study identifies that the relevant criteria for developing CBE business models for aqua-agro interactions (i.e. the micro level) are in line with criteria for CBE development (i.e. the macro level). The addition is that these criteria have to be interconnected, for example, the agricultural- and aquaculture producers are not the only ones that have to collaborate. It also requires that the agencies and policymakers collaborate with each other and the politics have to promote sustainable innovations in a long-term perspective. This willingness must also be expressed in changes in the legislation that enables innovations of current business models. The consumers also need to show their willingness through buying the grocery that they are promoting through the political systems and the researchers has to guide how to address the mutual sustainable problems between the agriculture- and aquaculture sectors. In order to achieve this micro level development and make it possible to develop CBE business models for aqua-agro interactions, a consensus is required. A consensus implies for example that the macro level criteria cannot be counterproductive and has to share the same visions and goals of sustainability. Consensus is required both intersectoral (e.g. between the firms, industry, agencies, policymakers), and between the actors in each sector (e.g. between firms among each other and politicians among each other).

The consensus that is needed pinpoints the theoretical relevance of this study because innovating business models cannot be limited to firms. The firms operate in a context, and therefore the adaption of a system perspective was needed in the study, where the researchers identified important criteria that supports and constraints the development. For example, there is political support of SBMI for aqua-agro interactions but current regulations constraints such developments. The contribution of this study is that for developing sustainable business models there is a need to not just innovate business models because of the existing system constraints and therefore there is a need for system innovation.

Further, this study contributes with a vocabulary to understand and make sense of complex developments that can be adapted to influence and shape the development within the CBE concept with particular reference to aqua-agro interactions. For example, the gained insights from the dialogue between two institutions at SLU, representing the aquaculture research with the standpoint in natural science and the socio-economic perspective represented by the researchers of the study.

6.2 Future research

This case study shows that exploring relevant criteria for developing CBE business models for aqua-agro interactions is complex because of the need for system perspective. The findings are that the criteria to develop further aqua-agro interactions (i.e. the micro level) are in line with criteria for CBE development (i.e. the macro level). The addition is that these criteria have to be interconnected by a consensus between actors in the inter-sector collaborations requested. Further research suggested on this subject could be to explore the macro level criteria. Such as the criteria, research and innovation, that is needed because of the complex issues and uncertainty exploration is needed to be able to answer questions as who is involved in such projects, who are the promoters, what do they want and where does it go? Answers to such questions could be interesting for the further development of sustainability concepts. In regards of exploring other the criteria, the legal framework that allows for innovation, questions as whose interest are legal frameworks developed, is it to promote economic growth, protect the environment or promoted for creating jobs? Also, those questions could be interesting for the context of developing the CBE concept with a particular focus on the aquaculture and agriculture interactions. The study has also gained insight by creating a dialogue between two research institutions at SLU. Therefore, additional suggestions of further research could be interdisciplinary research on developments of aqua-agro interactions.

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Appendix

The interview guide

Start question:

- Can you tell us what you do? What roll do you have and what responsibilities do you have in your organisation?

- Can you tell us if you have other rolls/commitments that is related to your work?

- Are you engaged in the implementation process of the "*Ålands Hållbara livsmedelsstrateg*i"? If, in what ways?
- Did you participate in the development process of the food strategy? If so, how did you participate and contribute?

Image/Vision

- *What is your view on aquaculture-agriculture interactions?*

- Do you know about such interactions today? Can you tell us if you have any examples of such commitments on Åland and in general?
- Do you think aqua-agro interaction can create new values or other values? If, what values?
- Do you think development of aqua-agro interactions contribute to a more sustainable (economic/social/environmental) Åland? If, in what ways?
- How can a concept of aquaculture-agriculture interactions be implemented on Åland?
- What role do you think your organization play in promoting more interactions between aquaculture and agriculture?

- *What is your view on sustainable business model innovation with particular reference to the concept of circular bioeconomy (CBE)?*

- What role do you think firms have in transitioning the present system to be more CBE?
- What firms are interesting in regards of promoting CBE development?
- What activities can firms do to attain more CBE development?
- In what ways, might firm's practices need to change to attain more CBE development?
- In what ways, might firm's practices need to change to attain more aquaculture and agricultural interactions?
- Do you think developing business models, which focus on CBE, contribute to a more sustainable Åland? If, in what ways?
- What role do you think your organization play in developing more sustainable business models?
- Do you think collaborations between firms is vital for promoting CBE development on Åland? If, what collaborations and how should they collaborate?
- If you think collaboration is essential, what collaborations do you think your organisation can take part in?

Resources

- What *resources* do you think firms have that can play a part in promoting CBE development?

- Do you think firms lack resources to promote CBE development on Åland? If, what resources are missing? (e.g. inputs, knowledge, financing, technology)

- If resources are missing, should firms do something? If, what should they do?

- What *resources* do you think your organization have that can play a part in promoting CBE development?

Challenges and opportunities

- What challenges do you think the development of bio-circular business model innovation will face on Åland? In general? In firms?

- Do you think there will be different challenges short term and long term? What differences in such case?

- What opportunities do you think the development of bio-circular business model innovation with emphasis on aqua-agro interactions will generate?

- New/changed products? New/changed values? New/changed consumers? New/Changed firms?

- If you don’t think it will add any opportunities, why do you think that?