Chapter

Innovation Processes in Aquaculture: Comparing Companies in Norway and Chile

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Abstract

In the last 20 years, aquaculture in general and harvested Atlantic salmon in particular has experienced very high growth rates compared to other food products, and at the same time, salmon production has evolved from semi-manual production techniques to the utilization of high-tech capital-intensive production equipment. This development has seriously challenged the environmental considerations and escalated fish health measures to combat existing and evolving problems. As an answer to these challenges and because of relatively high profit margins, aquaculture of harvested Atlantic salmon has also had a speedy innovation path. This chapter will give a theoretical background and an empirical analysis based on data collection at three companies, two in Norway and one in Chile. The focus is on how innovations take place in different stages of the production process, and how these are built into the production and managerial system. The results show, as expected, links between company operations and the actual innovations, but these links do not have the same structure in Norway and Chile. Factors like human and financial resources, technology, and company organization seem to explain most of the differences between how innovations take place in the companies.

Keywords: innovations, technology, knowledge, harvested salmon, Norway, Chile

1. Introduction

Driven by population growth, urbanization, and increasing wealth, aquaculture has grown by approximately 8 percent per annum over the past 20 years—faster than any other food sector. In 2018, world aquaculture production was 82.1 million tons live weight of which the marine production was 30.8 million tons and about 5 million tons came from salmonids [1]. The harvested salmon part of aquaculture has the possibility to continue this strong growth and thus makes a significant contribution to providing the global population with valuable proteins. Aquaculture is a resource-efficient method of producing protein-rich food. The companies in the study have a feed conversion rate of 1.05 to 1.09, which means that at best, the company uses 1.05 kg of feed to produce 1 kg of fish.

This ongoing growth, however, must not come at the cost of the environment or the climate. Aquaculture still requires amounts of wild fish which are processed into fishmeal and fish oil and used as feed, although the share of wild fish in aquaculture feed has been reduced in the last years and is now down below 20%. In some cases, aquaculture production is still not sustainable [2].

Facilities generate nutrient-rich effluent which is often channeled into coastal waters. The waters then become over-fertilized, causing algal bloom and oxygen-deprived zones. Innovative developments for reducing the food conversion rate do at the same time reduce emissions and improve profitability. For some time now, the industry has been testing products for their environmental compatibility, embracing all aspects from the extraction of the raw materials through to recycling [3]. The other fundamental challenge is fish health where the industry has spent hundreds of millions USD to develop medicines and procedures that substantively reduce the sea lice and other fish health problems. Given this background, it is easy to argue that the study of innovations will increase in importance in aquaculture. Innovation has been one of the most important subjects in any research and business agenda analysis in recent years, and also aquaculture has been analyzed from many viewpoints.

In the following sections, we will first give a theoretical background for the central concepts we use. Then we will present the empirical part and discuss the data collected and how these data relate to the central questions.

Research question 1: How do the companies in Norway and Chile handle different aspects of the innovation processes?

Research question 2: How can we explain differences in innovation creation and management between the companies in these two countries?

2. Central concepts: innovation perspectives

2.1 Innovation perspectives

Innovation plays a key role in the various phases of a company's development and has a decisive influence on the speed of business growth. The knowledge about transfer of technology in particular plays a key role in promoting innovative activity. Innovation is also an important source of stimulating competitive advantage, independent of the situation of the global economy. There are numerous definitions of innovation often starting with Schumpeter [4] and ending with the Oslo Manual [5]. Most definitions contain these key elements: (1) product, (2) process, (3) implementing a new resource, (4) a new market or a new sales formula, and (5) a new type of organizational system. We also have to consider Schumpeter's criteria that an innovation has to add value. How this shall be understood and measured is debated thoroughly, see [6]. Another reasonably agreed viewpoint is to look at innovations as a process which can be divided into three stages—(1) the creative/idea-generating phase, (2) the actual implementation of the innovation, and (3) innovation management, see [7].

Innovations have also been analyzed by looking at how models have evolved through different time periods. This began in the 1950s–60s with the linear model which looked at the three stages above as a linear process. Then came the interactive models, from 1970 to 1990, that posited that innovations had different types of loops and feed-back effects and the interactive models also introduced networking as a part of innovation analysis.

Starting in the 1990s, we have seen several developments in different directions:

- The division between radical and incremental innovations [8]
- Disruptive innovations [9]
- Innovation systems [10]

- The open innovation concept [11]

- Eco-innovations [12]

Another aspect of the innovation concept that has demonstrated importance is the link between knowledge and innovations. This question has been investigated since the concepts of the knowledge economy started to emerge in the late 1990s. More or less all studies end up concluding that there is a link between knowledge and innovations—the crucial question is what characterizes this link, see [7, 13]. Other discussions on delineation of the innovation concept is the private/public question. The private sector must innovate to survive in markets by developing competitiveness while the public sector needs to innovate to improve services to the public. The difference here is that the private sector normally can measure the income side as a part of production while valuating from a public sector perspective the quality/cost benefit is not all that easy. Another discussion centers around the differences in innovations in goods compared to services. The Oslo Manual [5] gives guidelines for how to handle this, but so far innovation in products and processes has gained more attention for goods than for services.

2.2 The innovation process and the creative/idea-generating phase and innovative behavior

One main contribution to analyze creativity and innovations comes from Amabile [14] where she takes as the point of departure the following keywords as the fundaments to develop creativity:

1. Expertise (knowledge)

2. Motivation (why we engage)

3. Creative thinking (challenge the status quo)

The three keywords from Amabile are discussed in all standard textbooks on innovation like [15], so there will only be a few comments here that are relevant for the focus of the chapter. The expertise keyword relates to knowledge which is one of the most discussed concepts in social science. The first aspect looked at is normally knowledge level, which indicates that you must have a knowledge platform to stand on to be creative. Then knowledge is linked to creative thinking and how the knowledge transfer process takes place. Here the division between explicit and tacit knowledge becomes important. There is a long, extensive and important debate on how tacit knowledge can be converted to explicit knowledge in companies, and how companies can create an environment that promotes creative knowledge transfers, see [16] for a more general presentation and [17] for a case study.

Amabile [14] discusses motivation as an important factor related to innovations. She finds that when people are intrinsically motivated, they engage in their innovative initiatives for the challenge and enjoyment of it. Amabile's work is paralleled by a number of emerging studies that started in the 1990s trying to explain what they called innovative behavior in organizations, see [18–20]. Based on [19, 21] Yuan and Woodman [22] have the following definition of the innovative behavior: "We define innovative behavior as an employee's intentional introduction or application of new ideas, products, processes, and procedures to his or her work role, work unit, or organization." [22], p. 324.

One fundamental assumption of this definition is that the behavior of all employees is intentional. This raises questions about how we can analyze innovative behavior and how we can explain why some employees are more innovative than others. Practitioners and scientific analysts agree that innovative behavior challenges organizations in one way or another. Studies like Janssen [23] looked at innovative behavior as a three-stage process in this order: idea generation, idea promotion, and idea realization.

When we analyze innovative behavior, it is important to be aware of which level in the organization we put focus on. Normally we divide into the individual level, the work group/team level, and the organizational level. There is interaction between levels, but as we will see from the data collection in project, production takes place in teams, which consist of individuals. Most studies consider that organizations like companies are divided into groups, and in each group, there is at least one person that has managerial responsibility, which in our case is the site manager. But also, of fundamental importance are the individual attributes for both the leader and the participants in the group. The outcome variable which is innovative behavior can be made operational by looking at six characteristics, see [20]. This was developed further by Janssen [23] using nine work behavior elements for innovative behavior: "(1) Creating new ideas for difficult issues (idea generation); (2) Searching out new working methods, techniques, or instruments (idea generation); (3) Generating original solutions for problems (idea generation); (4) Mobilizing support and trust for innovative ideas (idea promotion); (5) Acquiring approval for innovative ideas (idea promotion); (6) Making important organizational members enthusiastic for innovative ideas (idea promotion); (7) Transforming innovative ideas into useful applications (idea realization); (8) Introducing innovative ideas into the work environment in a systematic way (idea realization); (9) Evaluating the utility of innovative ideas (idea realization)" [23], p. 292.

Yuan and Woodman [22] also tried to explain innovative behavior and they used skill variables like education and organizational variables like (power) distance. One result from [22] was that the importance of the supervisor and his relationship to the rest of the group was fundamental. This corresponded with the results from the project reported in this study. Yuan and Woodman [22] also did more detailed statistical analysis trying to identify paths. This suggested several interesting results but most of them seemed to be quite context dependent.

2.3 Innovation management

2.3.1 Fundamentals of innovation management

There are numerous models and suggestions about how to manage innovations. We begin looking at the concepts of Tidd and Bessant [24] where they outlined how innovation can be analyzed as a core process within an organization. They use four keywords or key areas to look at this. The first is **searching** which means how the organization must look for opportunities for innovation. The next step is to **select** what the organization can and will do and why. The third step is about **implementation**, i.e. how the company will manage the process, so the innovation is working successfully in the company. For the fourth and final step, they use the word **capture**. This is the process by which the company will benefit from the innovation and implement the innovation into the general strategy of the company.

It is interesting to see how different studies and articles rely on the same factors when analyzing innovation management. In this respect, we will look at work like [25–27]. The article by Adams et al. [25] gives a literature review and summary of many studies which examined innovation management, so one can say that the results in [25] are the state of the art. The following list of indicators can be used to analyze the innovation process, adapted from [25]:

a. Inputs and resource situation: Manpower, capital, and financial resources

b. Knowledge management: Idea generation, knowledge repository, and information flows

c. The integration of innovation strategy and firm strategy

d. Organization and culture

e. Technology and technological collaboration

f. The use of IT-based solutions

g. Commercialization: market research, market testing, marketing, and sales

h. Complexity and risk

The question about innovation in low-tech industries compared to high-tech industries is relevant for aquaculture. Fagerberg et al. [7] discussed this theme in their "Handbook of Innovations" to determine if there are significant differences between innovation management and innovation processes in low-tech, medium-tech and high-tech companies. Thirty years ago, fish farming was a low-tech industry but a transition into use of high-tech equipment has rapidly taken place, fostering productivity, ecologic and sustainable development arguments. This has led to a demand of high-level knowledge for almost all aspects of innovation in aquaculture.

2.3.2 Some comments on the relationship between organizational structure and innovations

There is a sizeable amount of literature on development from hierarchical organizations to network based organizational models. The main achievement from the point of view of innovation is that creative ideas can be linked by different networks to different people and show different possibilities without everything going through one established hierarchical model. This argument again is linked to the knowledge management assumption that knowledge workers now have a greater demand for autonomy than earlier. An article by Jensen [28] describes how the autonomy pyramid is turned upside down with the introduction of what can be called the knowledge economy and knowledge organizations. One argument from Jensen is that several people at different levels in the organization may have more knowledge than the responsible manager. This knowledge contributes to innovativeness in such a way that it is counterproductive to have a hierarchal system. If the network organization is too loosely coupled so that core knowledge and competences are without managerial control, there could be negative consequences.

Another argument that has changed organizational thinking is what can be called the learning organization. Studies by Senge and Suzuki [29] and Lundvall and Borrás [30] suggested that organizations improved in flexibility and innovativeness when the organizational structure had learning processes on every level. Another argument for change in organizational structure that promotes innovativeness is the development of project-based organizations. Because of factors like managerial freedom, risk reduction, and possibilities for making contacts independently, we have seen many innovative processes taken out of the company and organized on a project basis.

2.4 Innovations in aquaculture

2.4.1 Background

Aquaculture is one of the fastest growing food producing segments the later years. Norway and Chile are the leading countries in the world for harvested salmon production and a total of more than 90% of the salmon production from the two countries is exported. With today's open cage technology there are only a limited number of places in the world where the natural conditions enable efficient production of salmon in the sea. In addition to Norway and Chile, the UK, Canada, the Faroe Islands, and Australia also contribute to worldwide production. **Table 1** shows global production which has shown an increase in production of about 66% from 2010 to 2018.

High profitability on the one hand and environmental challenges on the other are factors that have driven innovation and alternative manufacturing technologies in the aquaculture industry in recent years. Current trends in the development of innovations and new technology in aquaculture are proceeding in several directions:

- Developments in traditional open cage facilities
- Several facilities are being developed and tested for land-based farming
- Semi-closed facilities in the sea
- Submersible facilities and larger offshore installations

Since 2005 Norwegian producers have been obliged to monitor how emissions from the plants affect the area around the site in order to monitor whether the

	2005	2010	2015	2016	2017E	2018E
Norway	574	945	1234	1171	1208	1253
Chile	385	130	598	504	564	677
UK	120	143	166	157	177	153
Canada	108	122	135	146	139	145
Faroe Islands	17	42	76	78	80	72
Australia	18	33	54	51	61	61
United States	10	18	20	23	22	19
Ireland	12	18	16	16	17	14
Iceland	7	1	4	8	12	14
Others	1	4	16	8	14	9
Total	1252	1456	2319	2162	2294	2418

Production figures in 1000 tons.
Source: Ref. [31].

Table 1.
Global production of Atlantic salmon from 2005 to 2016 and estimates for 2017 and 2018.

environmental impact is at all times sound and sustainable both in the individual locality and in the region. This has given rise to several innovative initiatives.

Fish health and measures for combating fish diseases are serious issues in aquaculture production. The major problem with fish health in aquaculture is sea lice. There are different treatments for combating the sea lice and the use of antibiotics is being reduced to nearly zero. If there are disease challenges in individual locations or over larger areas, measures introduced by the authorities can have major consequences for production. Significant research and innovative activities are required to find measures that can improve fish health with impacting production as little as possible.

2.4.2 Innovations in aquaculture

On this background, it is easy to argue that the study of innovations will increase in importance in aquaculture. There have been several articles and projects dealing with innovations in aquaculture but still many gaps remain to be filled. Joffre et al. [32] compiled a literature review and they find that "*Lack of detailed analysis of the innovation process*" ([32], p. 139) is a field where new knowledge needs to be added, and this is our main concern.

Joffre et al. [32] have suggested to look at innovations in aquaculture by diving them into the following categories:

- Technology-driven
- Systemic
- Business and managerial

Our study of innovations in three companies shows that technology-based innovations play a major role. This relates to feeding systems, equipment for monitoring the fish in the cage, new procedures for delousing of the salmon, and measures for improving productivity of maintenance. The different technology-based innovations vary over a broad spectrum of technologies from incremental to radical innovations. On the radical side we have seen the introduction of solutions that combine hydroacoustic technology to monitor fish movement with advanced machine learning algorithms to observe fish behavior and objectively measure fish appetite. This enables the person responsible for feeding to optimize operations and reduce the feed conversion ratio while increasing growth rates. The use of equipment like this also demands new types of knowledge transfers, from the producer of the equipment to the site personnel and internally at the site.

The above example also shows us that innovations are linked together. The new technology demands new knowledge which means the management of the company must have a systemic approach to adopt a new knowledge structure. Whether this example can be called a systemic innovation is questionable but at some point, a new knowledge structure can be labeled innovative. Another technological example is a new mechanical water-based delousing system. Here the personnel at the site work together with the personnel on the delousing boat and there must be transfers of knowledge both ways. The delousing procedures also affect the business approaches because of the slaughtering logistics of the fish in the cage. We found several other examples that one innovation that originated in one part of the production system at the site had consequences for other parts. Often the chain of reactions started in the technology area and then spread to system and business parts.

3. Empirical part

The data collection that forms the empirical part of the project started in 2017 with support from the Regional Research Fund, Nord, Norway [33]. The project's main goal was to analyze innovations, competitiveness, and transfer of knowledge in salmon aquaculture production in two companies in Norway and one in Chile. In this chapter, we focus on the innovations part of the project. Data was collected from three companies:

Marine Harvest (now renamed Mowi), Chile: MH Chile

Marine Harvest (now renamed Mowi), Norway, Region North Norway: MH North

Midt-Norsk Havbruk, (Mid-Norwegian Aquaculture): MNH

Mowi is one of the largest aquaculture companies in the world (the main product is harvested Atlantic salmon) with total sales (in 2019) of more than 4.1 billion EUR, operations in 25 countries and about 15,000 employees [34]. Midt-Norsk Havbruk is a Norwegian company with sales of more than 100 million EUR. So, these are large and profitable companies.

We started the data collection at Marine Harvest's production sites in Chile in 2017. In Chile, Marine Harvest has operations in Region X and Region XI. We collected data from seven sites in Region X where Puerto Montt is the city where Marine Harvest has its headquarters. We have also collected data from three sites in Region XI outside the town of Aysen. We did data collection from Marine Harvest's sites in Region North in Norway at the beginning of 2018 and during the data collection we visited six sites. From Mid-Norwegian Aquaculture, MNH, we collected data from eight sites.

We used a structured questionnaire filled in by the research team when we were visiting the sites. We used three kinds of questions, with some being numeric about production, size etc. Then we had some questions where we asked for evaluation of statements using a Likert scale. Finally, we had some questions about innovation processes. The data collection process was quite resource intensive because we stayed at the sites for only 1 day, with boat transport to and from the site consuming up to 6 hours of that day. All formal information was checked against the databases of the companies.

Table 2 shows the data collection by company and by employee position. We have a total of 35 questionnaires collected from Marine Harvest Chile (MH Chile), 52 from Marine Harvest North (MH North) and 37 from Mid-Norwegian Aquaculture (MNH). The distribution of responses show that we have about as many responses from site managers as from operators in Chile, while in Norway we have a higher number of responses from operators than from site managers. Normally, there are 4–7 people in the work team at the site and the data shows that we have a reasonably

		Company			Total
		MH Chile	MH North	MNH	
Operator	N	18	43	26	87
	In %	51.4	82.7	70.3	70.2
Site manager	N	17	9	11	37
	In %	48.6	17.3	29.7	29.8
Total	N	35	52	37	124
	In %	100.0	100.0	100.0	100.0

N: number of answers—in all **Tables 2–17***, N represents numbers of answers.*
Source: the source for all **Tables 2–17** *is data collection done as a part of the project [33].*

Table 2.
Distribution of respondents with respect to position and company.

representative distribution from the sites in Norway. The reason we have a relatively large share of site managers in Chile is because of transport and accessibility considerations.

Table 3 shows that the average group size for the sites in Chile is 6.14, at MH North 5.02 and for MNH 3.92. Another important difference lies in how the work is organized. At the sites in Chile, everyone lives at the site 24/7 and it is normally a week's shift. The sites in Norway organize work by traveling to the site in the morning and leaving in the evening - a working day that normally begins at 8 am and ends between 4 and 5 pm.

We also asked for information on how long the employees had worked at the site and in the company. **Table 3** shows very similar results in the sense that in both Norway and Chile, employees have an average of about 5 years at the site and between 10 and 11 years in the company.

Table 4 contains information about structural factors on how production takes place. In Chile, the cages used are based on rectangular steel structures where, in most cases, 14 to 16 cages are attached together. In Norway, the system is more flexible in the sense that the site can have from 6 to 14 circular cages made from high density polyethylene (like Isoflon PEHD 1000) floating 10–30 m from each other. The Chilean system has the advantage that the cages are easier to access, with walkways along the cage edges, while the Norwegian (European) system cages are only possible to access by boat.

Furthermore, we find in **Table 4** the volume in m^3 (cubic meters) of water that is inside the cages that were currently in operation. Here we see that the total volume of water is less in Norway than in Chile since the number of cages in Norway is smaller and the size in volume of the individual cages is relatively similar. We also have information of the number of fish at the site at the time of data collection, and the average weight was 3.36 kg in Chile and from 2 to 3 kg in Norway. The data collection shows that we have many observations of fish that are relatively early in the growth cycle. This applies to the relevant sites in both Chile and Norway. The same trend is also found in the data showing how many months are left before the fish are to be processed.

Maintaining and developing routines is essential for production in companies and other organizations where stability is needed in production. On the other hand, the ability to change routines is seen as an indicator of the extent to which a company has a potential for the development of competitiveness and stimulate innovation. We examined how routines could change in the companies and important indicators were type and frequency of changes in routines and the extent to which the changes were implemented and followed up. In **Table 5** we see the main results

		Number of years employed in same job	Number of years employed in the company	Number of people in the workgroup
MH Chile	N	35	35	35
	Average	5.60	10.37	6.14
MH North	N	52	52	52
	Average	5.67	11.79	5.02
MNH	N	37	37	37
	Average	5.11	11.03	3.92
Total	N	124	124	124
	Average	5.48	11.16	5.16

Table 3.
Number of years of experience and group size.

		Number of cages	Cage volume in m^3	Number of fish in cage*	Average weight of fish*	Months before slaughter*
MH Chile	N	35	35	35	35	35
	Average	14.46	286,149	769,957	3.36	5.66
MH North	N	52	52	52	52	52
	Average	10.90	260,915	1,281,154	3.10	7.83
MNH	N	37	37	37	37	37
	Average	8.03	240,810	1,298,648	2.14	7.08
Total	N	124	124	124	124	124
	Average	11.25	262,038	1,142,084	2.89	6.99

At data collection point of time.

Table 4.
Information on production structure, average figures.

		Changes in routines	Formal changes in routines
MH Chile	N	35	35
	Average	3.86	1.34
MH North	N	52	52
	Average	3.65	3.25
MNH	N	37	37
	Average	4.11	3.84
Total	N	124	124
	Average	3.85	2.89

Table 5.
Changes in routines.

from the questions asked about changes routines. We asked site manager and operators at the site asked if there have been proposals for changes in procedures within the respondent's area of responsibility:

1. never

2. previously you can remember

3. the last 3 months

4. last month

5. last week

We also asked if the suggestion was followed up and the criterion here was if the suggestion has been written down. Furthermore, it is asked what type of proposal it was, whether the change was linked to the product, the manufacturing processes, the organization, or logistics.

Table 5 shows that the average score for the company in Chile was 3.86, while for the sites in Norway it was 3.65 and 4.11, which gives the same average score for Chile and Norway. Since higher numbers show greater frequency the results show major differences in the process of formalizing proposed changes in routines at sites in Chile compared to Norway, which shows clearly higher implementation capacity in Norway.

The extent to which the proposals have been followed up also show a relatively large difference between Norway and Chile in the sense that around 94% answer yes to follow-up in Norway while the corresponding figure is 62.9% in Chile, see **Table 6**. The results here also show that innovative behavior contributes stronger through the process of changing routines in Norway compared to Chile. This may be related to managerial/organizational factors, culture, and that resources for changes are more easily accessible in Norway than in Chile. This will be commented in detail in the next section.

In this project, we did a thorough data collection on innovation using a structured questionnaire, but we also made notes from comments of the interviewed persons. As stated in the theoretical part of this chapter, innovation is currently one of the most discussed topics influencing company developments, see Westeren et al. [13]. Aquaculture has changed fundamentally from utilizing manual methods of production to be a capital high-tech and innovative intensive production. With a few exceptions, aquaculture has also earned high profits, which has enabled a rapid pace for innovative actions, see [33].

It is not easy to interview employees of companies about innovations because it is necessary to distinguish between innovations and changes in production more generally. We used the well-known criteria for innovation from the Oslo Manual [5], where the central criteria states that innovations must have something new or improved that differs significantly for the company and relates to a product, process or the organization. The theoretical part of this chapter gives a thorough discussion of this. The interviews took place after we had first explained the innovation criteria to the respondent.

Table 7 shows that some respondents had never initiated any proposals for innovation, and these are taken out of the percentage calculations. The product from aquaculture companies is salmon delivered to the wellboat. There are weight and quality classifications, but the product is generally a standard commodity. Therefore, the majority of the proposals for innovations are linked to the production process at the site. The span of the proposals here is very wide, ranging from major changes in feeding systems to smaller proposals for new ways of carrying out maintenance and other smaller technical tasks.

Table 8 shows the results of the question regarding the origin of the ideas for the innovations. Here there is a difference in the structure of the answers in the

		Is the proposal for a change in routines followed up		Total
		Yes	No	
MH Chile	N	22	13	35
	In %	62.9	37.1	100.0
MH North	N	49	3	52
	In %	94.2	5.8	100.0
MNH	N	35	2	37
	In %	94.6	5.4	100.0
	N	106	18	124
	In %	85.5	14.5	100.0

Table 6.
Follow-up of suggestions for changes in routines.

		Types of innovative proposals			Number of valid answers	Unanswered
		Product	Production process	Organization		
MH Chile	N	6	20	4	30	5
	In %	20.0	66.7	13.3	100.0	
MH North	N	8	38	3	49	3
	In %	16.3	77.6	6.1	100.0	
MNH	N	0	32	2	34	3
	In %	0.0	94.1	5.9	100.0	
Total	N	14	90	9	113	11
	In %	12.4	79.6	8.0	100.0	

Table 7.
Types of innovative proposals.

		Origin of the innovation				Number of valid answers	Unanswered
		Completely self-generated	From the site collectively	From the company	Outside the company		
MH Chile	N	14	16	0	0	30	5
	In %	46.7	53.3	0.0	0.0	100.0	
MH North	N	8	34	4	3	49	3
	In %	16.3	69.4	8.2	6.1	100.0	
MNH	N	7	19	8	0	34	3
	In %	20.6	55.9	23.5	0.0	100.0	
Total	N	29	69	12	3	113	11
	In %	25.7	61.1	10.6	2.7	100.0	

Table 8.
Origin of the innovation.

sense that Chile has a predominance of innovations stemming from self-generated proposals, while in Norway the innovation ideas to a greater extent are generated from a cooperative process at the site.

Table 9 provides information on the length of time between when the idea of innovation was proposed until it was actually tested or put into practice. Here it is interesting to see that what one might call the maturation time of the idea varies both in Norway and in Chile, but on the average, the time to process the idea through the system was longer in Chile than in Norway.

We also have information as to whether the innovative idea was an answer to an acute or persistent problem. The results indicate that innovativeness essentially was a response to a persistent problem.

We have also asked respondents to estimate the cost of implementing the innovative idea and the results are stated in **Table 10**. The cost figure for Chile is in Chilean pesos (CLP) and for Norway in Norwegian kroner (NOK). Taking into account that 1 NOK is about 75 CLP, the average cost in Norwegian NOK for the innovative ideas in Chile is approximately 100,000 NOK, and for the Norwegian projects, it is about 200,000 NOK. This means that the Norwegian projects are on

		Time it took from the idea was generated until it was put forward in the company				Number of valid answers	Unanswered
		1 month	6 months	12 months	More than 1 year		
MH Chile	N	12	8	4	6	30	5
	In %	40.0	26.7	13.3	20.0	100.0	
MH North	N	17	29	3	0	49	3
	In %	34.7	59.2	6.1	0.0	100.0	
MNH	N	18	12	3	1	34	3
	In %	52.9	35.3	8.8	2.9	100.0	
Total	N	47	49	10	7	113	11
	In %	41.6	43.4	8.8	6.2	100.0	

Table 9.
The time it took from the idea was generated until it was put forward in the company.

		Cost of producing the innovation in CLP and NOK	The number of days it took to produce the innovation.
MH Chile	N	30	30
	Average	CLP 7,501,000 (= approx. NOK 100,000)	12.6
MH North	N	49	49
	Average	NOK 201,673	19.82
MHH	N	33	33
	Average	NOK 200,303	26.91

Table 10.
Cost of producing and the time it took for the innovative projects.

average twice as costly as in Chile. **Table 10** also shows the calculation of the average number of days it took to produce the innovation after the decision was made. The result here is 12.60 days in Chile, 19.82 days for MH North, and 26.91 for MNH in Norway which seems likely since the Norwegian projects are clearly greater than the Chilean ones, both in cost and scope.

Table 11 shows the results of where the decision to implement the innovation was actually made. The table shows a structural difference between Chile and Norway in the sense that more decisions are made at the company level in Chile, while in Norway, the majority of decisions are made on the site. The message here is that in Chile the decision has been moved further up the company hierarchy even though the projects in Chile are clearly smaller than the projects in the Norway.

Table 12 shows the distribution of answers after asking if the innovations need new knowledge to be implemented. Here the results show a clear necessity for new knowledge with larger needs for new knowledge in Norway since the Norwegian innovations are larger and more comprehensive. Westeren [33] show that the majority of innovations required new ways to exchange knowledge and this tendency was higher in Norway than in Chile.

We also asked if the innovations affected the corporate culture. **Table 13** shows the results that Chile clearly sees no influence, while Norway sees somewhat more influence on the organization, yet both countries remain negative on the average.

		At what level is the decision to implement innovation				Number of valid answers	Unanswered
		The company central	The company at the regional level	Production unit (site)	The person who made the proposal		
MH Chile	N	8	10	12	0	30	5
	In %	26.7	33.3	40.0	0.0	100.0	
MH North	N	0	17	29	3	49	3
	In %	0.0	34.7	59.2	6.1	100.0	
MNH	N	0	11	23	0	34	3
	In %	0.0	32.4	67.6	0.0	100.0	
Total	N	8	38	64	3	113	11
	In %	7.1	33.6	56.6	2.7	100.0	

Table 11.
At what level is the decision to initiate innovation?

		Does innovation need new knowledge to be implemented		Number of valid answers	Unanswered
		Yes	No		
MH Chile	N	18	12	30	5
	In %	60.0	40.0	100.0	
MH North	N	39	10	49	3
	In %	79.6	20.4	100.0	
MNH	N	30	4	34	3
	In %	88.2	11.8	100.0	
Total	N	87	26	113	11
	In %	77.0	23.0	100.0	

Table 12.
Does innovation need new knowledge to be implemented?

		Influencing the organizational culture of organization		Number of valid answers	Unanswered
		Yes	No		
MH Chile	N	4	26	30	5
	In %	13.3	86.7	100.0	
MH North	N	19	30	49	3
	In %	38.8	61.2	100.0	
MNH	N	16	18	34	3
	In %	47.1	52.9	100.0	
Total	N	39	74	113	11
	In %	34.5	65.5	100.0	

Table 13.
Does innovation affect the organizational culture?

Table 14 shows the results of the question of whether implementing the innovation requires stronger trust in the network between those who work at the site. The answer to this is a clear yes in Norway, while we get a clear no in Chile. One explanation for this in Chile is a two-level leadership structure at the sites. The site manager and the assistant site manager make the managerial decisions at the site in Chile. The operators are to a lesser extent involved, mainly when the innovative ideas come from the operator level. In Norway, the management of the site, including innovation decision making, is done under a much more collectivistic "atmosphere". Innovations will always be linked to changes, and those changes challenge the network of trust. Since knowledge is higher and more equally distributed in Norway, it is easier to build trust and confidence among all employees.

It is further asked in **Table 15** whether implementing the innovations will require changes in the IT-based systems at the site. The answer here gives a main emphasis on no in both countries which is somewhat surprising since digitalization has significantly advanced in both countries, especially in the use of advanced surveillance and feeding systems.

Table 16 provides the results regarding potential problems funding the innovation. Here we get a unanimous response that funding is not a problem for

		Does the idea require a stronger network of trust		Number of valid answers	Unanswered
		Yes	No		
MH Chile	N	10	20	30	5
	In %	33.3	66.7	100.0	
MH North	N	40	9	49	3
	In %	81.6	18.4	100.0	
MNH	N	25	9	34	3
	In %	73.5	26.5	100.0	
Total	N	75	38	113	11
	In %	66.4	33.6	100.0	

Table 14.
Does the idea require a stronger network of trust between the employees?

		Does innovation require changes in the IT-based systems		Number of valid answers	Unanswered
		Yes	No		
MH Chile	N	8	22	30	5
	In %	26.7	73.3	100.0	
MH North	N	13	36	49	3
	In %	26.5	73.5	100.0	
MNH	N	10	24	34	3
	In %	29.4	70.6	100.0	
Total	N	31	82	113	11
	In %	27.4	72.6	100.0	

Table 15.
Does innovation require changes in the IT-based systems?

		Problems funding innovation		Number of valid answers	Unanswered
		Yes	No		
MH Chile	N	16	14	30	5
	In %	53.3	46.7	100.0	
MH North	N	0	49	49	3
	In %	0.0	100.0	100.0	
MNH	N	0	34	34	3
	In %	0.0	100.0	100.0	
Total	N	16	97	113	11
	In %	14.2	85.8	100.0	

Table 16.
Problems funding the innovation.

		The innovation planned and/or implemented			Number of valid answers	Unanswered
		Only planned	Implemented	Partially implemented		
MH Chile	N	16	10	4	30	5
	In %	53.3	33.3	13.3	100.0	
MH North	N	1	48	0	49	3
	In %	2.0	98.0	0.0	100.0	
MNH	N	0	34	0	34	3
	In %	0.0	100.0	0.0	100.0	
Total	N	17	92	4	113	11
	In %	15.0	81.4	3.5	100.0	

Table 17.
The innovation planned and/or implemented.

innovations in Norway. This must be understood in the context that Norwegian innovations are normally funded as a part of the implementation process and the companies in Norway showed a positive attitude for doing innovations. The results are clearly different in Chile where about half of the projects have financing problems. This seems to illustrate the fact that he innovation process in Chile is much more bureaucratic and decoupled from the site.

Some of the same reality is set out in **Table 17** where it is asked to what extent the innovation is only planned or also implemented. For the projects in Norway, nearly all proposed innovations are completed or under implementation. We see a quite different degree of implementation in Chile in the sense that many proposed innovations may not have been implemented or only partially implemented.

4. Discussion and conclusions

The research questions are about how companies in Norway and Chile handle different aspects of the innovation process. The production equipment of the companies is quite comparable, with the Norwegian equipment being a little more technologically advanced than the Chilean. But the organizational set up differs in at least two ways. The site manager has more autonomy toward the executive level in Norway. And consequently, the most knowledge demanding processes - feeding and monitoring of the salmon in the cage - is a process that rotates between all members of the group at the site, while in Chile, this is the responsibility of the site manager and the assistant site manager. Other differences include a slightly higher education level in Norway, in addition to a more equally oriented labor culture in Norway than in Chile.

Looking back at the literature review, creativity is a central aspect. In the tables about change in routines, we see a quite high and equal drive to generate the initiatives to challenge routines as a start of an innovative process. But when we come to the crucial stage of formalization, the Chilean sites lose pace. We find a significant difference in what we might call implementation and completion ability. The flatter organizational structure and more collective attitude in Norway seem to be important elements to explain why the innovative behavior in order to change routines is stronger and more related to the site.

We were surprised by the results in **Table 7** where there is a quite considerable difference between product and process innovations among the Norwegian companies. One explanation is that at NH North they had initiated a program for improving the condition of the salmon in the process of transfer to the wellboat, and they classified this as a product innovation. At MH North they also implemented fish health measures to reduce mortality for the transfer of salmon from the cage to the wellboat also classified as a product innovation. This discussion reveals the fact that innovations often are linked together. To have one innovation that contributes to increase quality of the salmon into a higher quality class (a product innovation) it is often necessary to develop equipment which can represent a process innovation. But still, aquaculture will mainly have process innovations linking together activities since it has developed into a high-tech industry producing a quite standardized commodity. We saw emphasis of this integrated view on innovations more in Norway than in Chile, which is supported by the results in **Table 12**, where new knowledge and new ways to exchange knowledge are more emphasized in Norway. This is also an argument for the open innovation focus because a demand for more integrated innovations makes it favorable to have different kinds of input at an early stage.

The results from **Tables 10** and **11**, combined with our experience based on the visits to the sites, have revealed a view that innovations were more efficiently used as a tool to strengthen competitiveness in Norway as compared to Chile. The Norwegian innovation management was based on a different logic than the Chilean. This refers to the selection and implementation processes mentioned in the literature review. When an innovative idea was suggested and accepted in Norway, the financial resources were an integral part of the innovation management. That is why we find the large differences in **Tables 16** and **17** where there were no problems financing the innovation in Norway compared to nearly 50% of all projects in Chile encountering financing issues. This also explains the very high conduction rate in Norway compared to Chile.

All three companies had a reasonably good resource situation in that they enjoyed good profit margins, with Norway probably doing a little better. However, this does not explain the big differences in innovation management that we find. The first element as an explanation is better possibilities for taking decisions at the site level in Norway. In Chile, we find more of the pyramidal structure including a stronger belief in control from the central/regional company level.

In Chile, we also find a smaller willingness to include financial planning in the innovation process, even given that the projects are smaller and not so knowledge-demanding as in Norway. This indicates what we can recall from the theoretical considerations about innovative behavior—keywords like support, trust, and approval are important to explain the differences between Norway and Chile, see **Table 14**. This points back to the more fundamental discussion about trust in innovation processes. This theme is investigated by research by Sankowska [35], Panayides and Lun [36] and Ellonen et al. [37], and they all find a positive relation between trust and innovation. Sankowska [35] is using Structural Equation Modeling and finds that trust affects innovations both directly and through the processes of knowledge creation and transfer. The results from this project shed light on innovation processes in three large and resourceful companies and the results must be interpreted in this context. There is reason to believe that smaller aquaculture companies also try to develop innovation strategies but how this more in detail goes on needs to be investigated.

Concerning future research more in general, we refer to one of the latest books about innovation and knowledge creation, Bathelt et al. [38]. They give a thorough discussion on the most relevant perspectives of innovation, but they encourage further research on innovation because "we are still faced with many unanswered questions and new challenges in economic and social life that need new analytical perspectives as well as new answers and solutions" [38], p. 1.

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