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Knowledge intensive service activities and innovation in the Norwegian aquaculture industry

Part project report from the OECD KISA study

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ABSTRACT

This report is the last of three studies focusing on the use of knowledge intensive service activities (KISA) in innovation in specific industries in Norway (Broch, 2004 and Broch and Isaksen, 2004). Typical examples of KISA in firms and organisations includes R&D, management consulting, IT services, human resource management, accounting and financial service activities, marketing and sales, project management, organisational activities, and training. The main focus in this report is on KISA in the aquaculture industry in Norway. One of the main objectives of the study is to provide insights into how aquaculture firms maintain and develop productive and innovative capabilities through utilisation of KISA, provided by internal and / or external sources. The main research questions are: What internal and external competencies do firms use in innovation, and how are these competencies used to build the firm-specific knowledge and skill base needed to facilitate learning and innovation processes? The ultimate objective of the KISA project, i.e. the comparative studies of the specific industries in different OECD-countries , is to inform government policy and programs on how to use KISA in building innovation capability of firms and organisations across various industries and sectors in the economy.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	Knowledge intensive services	
GROUP 2	Innovation policy	
SELECTED BY AUTHOR	Aquaculture industry	

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Preface

This report presents the results of the third of three case studies in the project on Knowledge Intensive Service Activities (KISA). The KISA project is conducted under the auspices of the OECD Group on Technology and Innovation Policy (TIP) subordinated by the Committee on Science and Technology Policy (CSTP). The lead countries of the KISA project are Australia and Finland and additional participating countries are Korea, New Zealand, Spain, Ireland and Norway.

The first mandatory case study focused on KISA in the software industry and was followed by case studies of KISA in health care in all participating countries. The remaining one or two case studies are optional. In the Norwegian part of the project, the final case study is on KISA in the aquaculture industry.

The Norwegian KISA project is financed by the PULS and the ICT program of the Norwegian Research Council. The KISA project is governed by an internal steering group of the Council consisting of Helge Klitzing, Øystein Strandli and Tron Espeli. The authors would like to thank this group for valuable contributions as the project has evolved and for comments to this report.

The KISA project is being conducted by NIFU STEP –The Norwegian Institute for Studies in Research and Higher Education, Centre for Innovation Research. The research team consists of Arne Isaksen (project leader), Marianne Broch and Heidi Wiig Aslesen. This report is written by Heidi Wiig Aslesen.

Oslo, 11/11/2004

Heidi Wiig Aslesen

Executive summary

This report is the last of three studies focusing on the use of knowledge intensive service activities (KISA) in innovation in specific industries in Norway (Broch, 2004 and Broch and Isaksen, 2004). Typical examples of KISA in firms and organisations includes R&D, management consulting, IT services, human resource management, accounting and financial service activities, marketing and sales, project management, organisational activities, and training. The main focus in this report is on KISA in the aquaculture industry in Norway. One of the main objectives of the study is to provide insights into how aquaculture firms maintain and develop productive and innovative capabilities through utilisation of KISA, provided by internal and / or external sources. The main research questions are: What internal and external competencies do firms use in innovation, and how are these competencies used to build the firm-specific knowledge and skill base needed to facilitate learning and innovation processes? The ultimate objective of the KISA project, i.e. the comparative studies of the specific industries in different OECD-countries[1], is to inform government policy and programs on how to use KISA in building innovation capability of firms and organisations across various industries and sectors in the economy.

The aquaculture industry in Norway
The Atlantic salmon is Norway's best known export product and accounts for 32,2% of all export of fish from Norway. The aquaculture industry has experienced large changes the last years. The structure of the industry has changed towards a marked concentration resulting in a few large actors . In 2001, 46% of total production was accounted for by the 10 largest companies, as opposed to 8% in 1990. In the same period, the number of employees has been halved, and at the same time the production in tonnes has more than doubled. These changes indicate substantial innovation efforts in the industry. In the same period the internal competence base of the industry has moved towards a larger share of employees having higher education.

Nevertheless, the industry is today seriously challenged and many firms have the last years filed for bankruptcy. Increased international competition, toll barriers, price pressure and differentiated and strict customer demands are factors challenging the industry and its innovation efforts. Innovation related to "softer" aspects like organisational- and market innovations seems to have grown in importance, suggesting a need for knowledge intensive services, both internally and externally.

Innovation activity in Aquaculture
In the Community Innovation Survey for Norway (CIS) carried out in 2001, aquaculture firms in the sample emphasised sources within the firms to be the most important information source for innovation. This emphasis on internal knowledge intensive service activities is also evident when looking at the distribution of aquaculture firms' innovation

[1] A set of common research steps for the OECD project is followed in this study. The first two steps describe key aspects of the Norwegian aquaculture industry, and policies and programmes of importance for the aquaculture industry in Norway. The third step includes studying innovation activity and the role of knowledge intensive service activities in innovation processes in aquaculture. The analysis builds on data and results from several research projects carried out the last couple of years (Aslesen et al. 2002, and Aslesen 2003). The former research has been supplemented with in-depth interviews with 11 persons working in eight different Norwegian aquaculture firms focusing especially on how KISA are used in building innovation capability. The fourth step discusses policy implications from the study and uses a framework for systemizing policy implications that is used in all the KISA studies.

costs: The share of *internal* R&D counts for 80%. Nevertheless, few of the innovations are seen to be new to the market, suggesting that most of them are incremental innovations being new only to the firm. However, internal knowledge intensive service activities is not perceived to be the driving force in aquaculture firms' innovations. The main responsibility for product innovations is given to collaborative efforts between aquaculture firms and other firms and institutions. For process innovations, a mix and match of both internal and external competence is seen to be a driving force.

Suppliers are emphasised in particular by aquaculture firms as important external competence providers. The aquaculture supply-industry is continuously growing and has become a specialised and advanced knowledge and technology supplier. Many of the process innovations in the industry can be traced back to their suppliers. The innovation survey indicates that aquaculture firms use few resources on external acquisition of R&D. However, more than half the firms highly value the information and ideas given from RTOs (Research and Technology Organisations). Many aquaculture firms also report to have formal innovation collaboration with such actors.

The innovation survey gives a picture of how the "average" aquaculture firms innovate. However, as the aquaculture industry is heterogeneous, there is a need to differentiate between diverse types of firms as regards innovation activity and the use of KISA. To differentiate innovation strategies, we use results from a qualitative study focusing on how firms' innovation efforts reflect the internal knowledge base (scientific/practical experienced based) and the degree of organisational formalisation (ad hoc/professional management) in the organisations (Aslesen et al., 2002). Four different stylized variants of aquaculture firms appear:

Table S 1. Stylized variants of aquaculture firms

Knowledge base / Organisation	Practical	Technological/scientific
Entrepreneurial, ad-hoc	1)"The small family firm"	3) "Research driven entrepreneurs"
Structured management system	2)"The coastal enterprise"	4) "Science based process industry"

KISA in innovation

The stylized variants of aquaculture firms firstly include what kinds of competences to be found internally, and secondly which set of "significant others" that firms cooperate with during innovation efforts. Important here is that the innovation process differs within each quadrant, and so do the innovation outcome.

This model seems particularly relevant in order to understand the role knowledge intensive service activities play in innovation. Thus, the findings from firms' interviews as regards the use of KISA in innovation employ the following model to analyse the three questions: 1) Why firms use different KISA – and thereof what kinds of KISA 2) When firms use different KISA and 3) How firms use different KISA in the aquaculture industry.

Table S 2. Innovation strategies of aquaculture firms. Why, when and how KISA are used for innovation

Knowledge base / Organisation	Practical/learning by doing Incremental, reactive innovation strategy	Scientific knowledge base radical and proactive innovation strategy
Entrepreneurial, ad-hoc	Type 1: Why/What, When and How are KISA used for innovation	Type 3: Why/What, When and How are KISA used for innovation
Structured management system	Type 2: Why/What, When and How are KISA used for innovation	Type 4: Why/What, When and How are KISA used for innovation

The main finding is that the *use* of knowledge intensive service activities and their *role* in innovation differ according to firms' knowledge base and type of organisation. This implies that policy directed towards improving innovation capabilities by means of KISA must relate to the different types of firms. A general finding is that many of the aquaculture firms' internal knowledge intensive services is at the minimum. The dynamics and quality of interaction between competence suppliers and receivers (the aquaculture firms) seem to be important. Many of the interviewed firms have a focus on minimising fixed cost, internal KISA are often very slim, making it hard to have the appropriate knowledge management practices to maintain new knowledge in the organisation – if external KISA are used in the first place. As such, the ability of external KISA to influence aquaculture firms' knowledge generating processes might vary enormously.

The table below summarises the findings regarding why, when and how KISA are used in relation to innovation. The table shows that both the set of actors these different firms relate to, the different KISA that they perceive as relevant for innovation and the innovation result, differ.

"The small family firm" firm can be said to have a strategy of neither innovating nor using KISA. The internal KISA is at a minimum. The most relevant question to these actors is why they do not use KISA for their internal learning processes. The answers are more or less obvious; they both lack the time, financial resources and internal competences. The external KISA that they relate to are typically posed to them through mother companies (the enterprise level), through the market by their network of suppliers and customers, through "must have" activities like accounting and banking services and through informal networks in relation to fire fighting. In interviews, it is obvious that these linkages do make valuable input into learning processes in the organization. The results are often related to more incremental changes in technical solutions or business organizations, suggesting that external KISA do have some impact on innovation processes.

"The coastal enterprise" has a more professional organization and therefore do employ more internal knowledge intensive service activities in middle management. The middle management has enabled these firms to a larger degree relate to external knowledge providers and as such are more integrated into the production and innovation system of which they are a part, than the Type 1 firm. However, the Type 2 firm is practically oriented and do seldom relate directly to the knowledge infrastructure in the search for new knowledge. KISA acquired through the network of suppliers and customers and related firms are still the most important innovation input for these firms. The impact of KISA goes into a larger part of the value chain, and are still related to more incremental changes.

"The research driven entrepreneur" innovate through interactive learning processes with external KISA providers from RTO's and, as such, use external KISA as part of their innovation strategy. The innovations resulting from these formal and long lasting projects,

are often radical and new to the market. However, the Type 3 firm does relate to few other professional providers of KISA since their organization has out-sourced most other KISA functions.

"The science based process industry" firm is highly integrated into the production and innovation system of aquaculture and use KISA in relation to learning processes in all parts of the value chain. KISA therefore make valuable contributions to innovation in all parts of the organization, however, the respondents are eager to report that they themselves are the "agents of innovation" and are driving the innovation processes in the firm. The impact of external KISA towards innovation in the firms is said to be dependent on the quality of the services provided in the market.

Table S 3. Why, when and how KISA are used in relation to innovation among interviewed aquaculture firms

Knowledge base / Organisation	Practical/learning by doing			Scientific knowledge base		
Ad hoc organisation	**Type 1: "The small family firm"**			**Type 3: "Research driven entrepreneurs"**		
	Most important KISA for innovation: Development KISA and ICT development KISA Banking and financial KISA Accounting and auditing KISA	***KISA provider:*** KISA from enterprise level Network KISA "Must have" Local KIBS (auditing, finance)	***Types of innovation:*** Organisational and strategy innovations Incremental technological innovations Incremental change of business strategy	***Most important KISA for innovation:*** Research KISA Legal KISA Banking and financial KISA (venture capitalists)	***KISA provider:*** Network KISA KISA from enterprise level RTO's	***Types of innovation:*** Product, process, market Radical science based innovation (in parts of the value chain)
Professional management	**Type 2: "The coastal enterprise"**			**Type 4: "Science based process industry"**		
	Most important KISA for innovation: Development KISA ICT development KISA Banking and financial KISA KISA related to organizational development and strategy KISA related to marketing and sales KISA related to management and training	***KISA provider:*** Network KISA National/global KIBS (finance, strategy, training)	***Types of innovation:*** Incremental innovations in the whole value chain Organisational and strategy innovations	***Most important KISA for innovation:*** Research KISA Development KISA ICT development KISA Legal KISA Banking and financial KISA Accounting and auditing KISA KISA related to organizational development and strategy KISA related to marketing and sales KISA related to management and training	***KISA provider:*** RTO's. Network KISA National/global KIBS (finance, strategy, training)	***Types of innovation:*** Radical science base innovation in the whole value chain Incremental and radical changes in all parts of the value chain Organisational and strategy innovations

Policy implications

Aquaculture firms differ with regard to innovation strategies and with regard to their integration into the production and innovation system of which they are a part. The impact of KISA on innovation in aquaculture will therefore also differ as a result of these factors. KISA play different roles in firms' learning processes, and the reasons why, when and how KISA are used differs. To make relevant policies in relation to firms' innovation strategies

and the use of KISA for innovation, it is necessary to consider these differences. The overall policy suggestions targeting KISA to improve innovation capability, competitiveness and efficiency in aquaculture firms must primarily be related to: 1) Strengthening the internal knowledge intensive service activities in aquaculture firms by mapping actual needs in relation to innovation efforts. Needs in relation to "softer innovation" inputs are detected in relation to; general business competence, commercialisation, marketing and sales. The need for internal KISA differs depending on type of firms. Financial restraints seems to be a hampering factor with regard to strengthen internal KISA. 2) Stimulate quality of supply of external KISA. The knowledge base of local KISA providers must be based on scientific knowledge, thus requires that the actors must have the ability to convert this knowledge into practically oriented knowledge that the aquaculture firms can relate to. Since these external KISA providers have the potential to stimulate innovation in firms, it is important that they are up-to-date in their field of action and that they see KISA needs in relation to innovation in their customer firms. 3) Proactive broking between aquaculture firms and relevant external KISA providers seems to be of importance. There is a need for networking between aquaculture firms and external KISA especially in the field of general business competence. A general scepticism towards external consultants, with lack of industry specific knowledge, is hampering the potential for mix and match of internal and external KISA with positive impact on internal learning and innovation.

The implication of these findings is that policy initiatives must be differentiated between types of aquaculture firms:

"The small family firm" have low innovation efforts, and therefore have few strategies for internal and external learning processes. The level of internal knowledge intensive service activities is low, the degree of formal external linkages with knowledge providers is also low, most often as a result of purchase of products/services on the market. This implies that the interactive learning processes that these firms take part in, and where knowledge intensive service activities could be a part, is related to more incremental innovations.

The market relation is the most important transfer channel. Due to a practical/experienced based knowledge base, these actors purchase services they "must have" in the market. These services do not have great impact on innovation activity in the firms.

Financial and time constraints are hampering factors with regard to purchase of knowledge intensive services. Public policy might help to overcome these constraints in different ways. Policy should also be directed towards motivating innovation activity by their use of competence building internally, and thereafter help expand external linkages, i.e. through mediators.

"The coastal enterprise" are more integrated into the production and innovation system of aquaculture through a larger and more professional organisation. However, the focus on innovation is still low, due to financial and competence constraints. Type 2 firms are challenged by a broad set of external demands that they need to relate to through customers and the market in general. Internal KISA must therefore continuously be upgraded and developed. These actors are also forced to develop business models with a larger focus on marketing and sales. This can be targeted through public measures. The firms themselves also demands better quality of KISA supply from external suppliers, especially in the field of organisational development and marketing.

”Research driven entrepreneurs” is challenged to develop KISA related to the ability to commercialise “new knowledge” especially in the field of business strategy and marketing skills. These firms are also in need for long term and knowledge intensive capital to be able to pursue a R&D-intensive strategy for innovation. These are areas for policy of relevance to Type 3.

With regard to “Science based process industry” firms, they have an innovation strategy along the whole value chain, and have a diversified set of both internal and external KISA providers of importance to learning and innovation in the organisation. Policy suggestions for these firms is related to how the government R&D policies could be more suited to the “locomotives” in the industry. Policies should take more into account; 1) the needs of developing internal KISA 2) to stimulate the supply and quality of external KISA (especially R&D) to better match the large and R&D intensive actors in the industry, and to develop public R&D or innovation programmes also focusing on “softer innovation” 3) at the firms level, move the focus towards more “softer innovation” projects with a clearer focus on both organisational and more market research (as opposed to technological and biological innovation projects).

1. Introduction

Innovation is on the policy agenda in all OECD countries after two decades of research by the OECD itself and by researchers in many fields. This awareness has been realized through the introduction of policies that touch upon many aspects of the innovative process and all sectors of the economy.

From an initial focus on product innovation alone, understanding is now widespread that innovation encompasses not only radical and incremental product development but also new production methods, new marketing methods and new organisational forms taken up by firms and organisations. It has become clear that all these aspects of change characterise innovative organisations and influence competitive success.

Over the last decades there have been substantial structural changes in the role and dynamics related to the generation of competences and capabilities in the economy. New markets and suppliers of productive knowledge and capabilities have emerged. Also new modes of interactions between suppliers and users of such knowledge and capabilities have developed. Related to competence- and capability generation in the economy there has traditionally been a policy focus on public support of research and technology development through government research and technology organisations (RTOs). The developments have shown that there are also other suppliers of competence and capabilities, and other capability enhancing activities that need to be considered and included in policy thinking related to knowledge development and innovative activities of firms and organisations as a basis of economic growth in the economy.

One group of new suppliers of productive knowledge are so called knowledge-intensive business services (KIBS), increasingly competing with the traditional RTOs in various areas of knowledge and competence development and diffusion. The competition mainly concerns the provision of services that can directly be appropriated by clients. Both the new suppliers and the more traditional suppliers, however, provide highly knowledge-intensive services to their customers. These services are based on a set of activities that may be termed knowledge-intensive service activities (KISA). However, such knowledge-intensive service activities take place not only within the competence and knowledge-intensive supplier organisations. The knowledge-intensive services provided by KIBS and RTOs to their clients are most often co-produced in interaction between provider and user. Thus, KISA are an important part of the internal activities of all types of firms and organisations, even though the firms and organisations as such may not be regarded as particularly knowledge-intensive for example according to industrial classification standards. Nevertheless it is important to get an understanding of the role of knowledge-intensive service activities (KISA) provided either internally in firms and organisations, externally by e.g. KIBS firms and RTOs, and the dynamic interaction between them. KISA are believed to be of vital importance for learning and innovation capability building inside firms and organisations.

The KISA project

In this project KISA are defined as innovation services provided either internally or externally to a firm or organisation, with innovation services understood as services related to the development of an organisation and its patterns and objectives of innovation – of changes in its "way of doing things in the way of economic life"[2]. This definition of innovation includes

[2] Joseph Schumpeter (1939) *Business Cycles.* Vol.1, Mac Graw-Hill, New York

prominently the introduction and sale of new and altered products, its modes of producing these, and the structure of supply to customers.

This study of the aquaculture industry is an element of a 15 country OECD research project. The KISA study in Norway, of which this aquaculture case study is the third part, have the following objectives:

- The core objective of the KISA project is to explore the functional provision and use of KISA services in three sectors[3] and recent policy initiatives in this area in a range of countries. The three functional sectors include software production and health care services, both of which will be studied by all participating countries. The third sector in Norway is aquaculture.
- The project will provide insights into how firms maintain and develop productive and innovative capabilities through utilisation of KISAs, provided through various institutional channels. The project aims at getting a broad understanding of the role of KISA as part of the wider innovation system of firms in these sectors.
- With this as a basis the project shall provide implications for innovation policies.

These objectives will be attained through research organised in four steps in each sector.

1. Review and analysis of national statistics on the contours of the sectors selected
2. Description and evaluation of government and semi-public programs and policies and private ones if appropriate
3. Interviews with representatives of firms and organisations (investigating the use and integration of KISA)
4. Policy implications of KISA for the development of National Innovation Systems

Method and data of the KISA aquaculture study

The study of aquaculture and its use of knowledge-intensive service activities will be designed in line with the case study of the software industry.

Step 1

The review of national statistics of the Norwegian aquaculture industry builds on a variety of sources:

- The Firm and Enterprise Register of Statistics Norway
- National accounts of Statistics Norway
- The Community Innovation Survey for Norway 2001

Step 2

The data used in the evaluation of government and semi-public programs and policies is based on information on the web sites of the various agencies responsible for the policies or programs, telephone based communication with persons responsible for the programs as well as the EU commission Trend Chart database for Innovation[4].

Step 3

For the KISA aquaculture study in-depth interviews with 11 persons in 8 Norwegian aquaculture firms have been undertaken. The firms and the interviewed persons are presented in Appendix 1. The semi-structured interviews are based on the main themes drawn from the common research questions of the project presented below. The main themes discussed with

[3] Some of the OECD national studies will include four KISA studies, the mandatory two studies of aquaculture and health care and two optional studies.
[4] www.cordis.lu/trendchart

the software firms were, apart from background information and firm organisation, how they perceive their bundle of products and services, their markets and customer relations, supplier structures and relations. Further, the interviews included discussions of the use of knowledge intensive service activities, both internal and external, possible effects or contributions of KISA, competitor situation, core competences and learning, innovations and its financing, innovation collaboration, innovation barriers, as well as the firms' view on the role of public sector in innovation in the software industry.

The main objective of the KISA aquaculture case study is to identify whether knowledge-intensive service activities have a role to play in developing capabilities to innovate in aquaculture.

The research questions / themes agreed by the KISA focus group in OECD are as follows:

1. Overview of the aquaculture industry with a specific focus on innovation
2. Characteristics of innovation and innovation processes within aquaculture
3. Challenges in the development of innovations in the industry
4. The role of KISA in innovation within the aquaculture industry
5. Do firms integrate KISA from different sources?
    - How does the integration take place?
    - Are there any intellectual property related issues?
6. Impacts of KISA on innovation within the aquaculture industry
7. What is the role of public sector as regards the role and impact of KISA in innovation within the aquaculture industry

2. KISA and innovation activity

Innovation as interactive learning

Innovation is seen as an increasingly important activity in stimulating the competitiveness of firms and organisations. The importance relates to the conceptualisation of the contemporary post-Fordist economy by for example the economist Bengt-Åke Lundvall as a globalising learning economy. "Globalisation has not only increased market competition, but also transformed it into market competition based increasingly on knowledge and learning" (Lundvall and Borrás 1997: 28). While capitalism has always rested on its capacity to create new products and new ways of producing them, a common place assumption is that the contemporary economy is less standardised and predictable than in the Fordist period, requiring innovation and adaptation to be competitive. Thus, it is the capability to learn and innovate, and the ability to connect the innovative effort to wider markets that increasingly is seen to determine the relative position of individuals, firms, regions and countries. Firms in high costs locations in particular found their competitiveness on the ability to introduce new products, alter existing products, use efficient production equipment, organisation methods etc.

Innovation activity is seen as a complex, interactive, non-linear learning process. Learning then includes the building of new competencies and establishing new skills by individual workers, firms and organisations, and not only to get access to new information. This view of the innovation process is based on a broad definition of innovation, to include both improvements in technology and better methods or ways of doing things (COM 1995). The broad definition involves a critique of the linear, sequential model of innovation, which focuses on more radical, technological innovations. The broad understanding of innovation means an extension of the range of industries that can be viewed as innovative from typical high-tech industries also to include traditional, non-R&D-intensive industries. One of the basic critiques of the linear model is precisely the equation of innovative activities with R&D, giving poor prospects for the traditional industries, service industries and the public sector.

The conceptualisation of innovation as interactive learning furthermore emphasises the importance of co-operation in innovation processes as well as a systemic view of innovation. The build-up of different local organisations and the intensity of interaction between these to create "institutional thickness" (Amin and Thrift 1994) is emphasised as important in stimulating co-operation, learning and innovative activity. If successful, the institutional thickness of a region may be the basis for an innovative inter-firm division of labour and exchange of information, knowledge and competences, the provision of critical resources, and the development of a set of norms and values promoting co-operation (Lutz et. al. 2003). Moreover, the concept of innovation *system* is based on the idea that the overall innovation performance of an economy to a large extent depends on how firms manage to utilise the experience and knowledge in other firms, research institutions, the government sector etc. and mix this with internal capabilities in the innovation process (Gregersen and Johnson 1997). Firms combine resources and knowledge by many actors in building unique, firm-specific competencies that cannot rapidly be imitated by competitors (Maskell et. al. 1998).
With the perspective on innovation as interactive learning, networking and co-operation are considered to be of strategic importance in promoting competitiveness of firms and organisations. Co-operation almost always includes interpersonal, human linkages. These linkages are quite different from arms-length, anonymous market transactions, and the existence of social institutions facilitates collaboration and the exchange of qualitative

information between actors. Thus, in networks and other kinds of "organised" market relations, people develop codes of communication, styles of behaviour, trust, methods of co-operation etc. to facilitate and support interactive learning (Gregersen and Johnson 1997: 482).

The increasing interdependence of technological and organisational change is a significant feature of systems of innovation in the knowledge economy. Increased interest in non-technological innovations is associated with the connection between the organisational innovation and firms' learning capacity, making organisational learning processes more important for creating and maintaining competitiveness. A further characterisation is the increasing innovation in services and new forms of work and firm organisations (Strambach, 2002), suggesting that innovation is not only restricted to research and technology intensive areas.

This changed understanding of the innovation concept and processes is an important element in the knowledge economy and has made quantitative and qualitative shifts in the need and demand for knowledge in business. Vital requirements are linked to economic, technological and socio-cultural knowledge and competence, indicating the need for multidisciplinary application and problem oriented knowledge in innovation systems. An indicator of these changes can be linked to the spectacular growth in economic transactions relating to knowledge (Maskell and Malmberg, 1999, Antonelli, 1999), and to the rapid growth of KIBS. Strambach (2002) has linked KIBS to the innovation system in that they:

- Transfer knowledge in the form of expert technological knowledge and management know-how
- Exchange empirical knowledge and best practise from different branch contexts
- Integrate different stocks of knowledge and competencies that exists in innovation systems
- Adapt existing knowledge to the specific needs of the client.

Both formal and informal networks and co-operation are essential for the functioning of KIBS and this is an indication of their integration function.

The role of KISA in innovation

Hales (2001) has emphasised that it is important to distinguish between knowledge-intensive business services (KIBS) as function and KIBS as institution. One should distinguish between "knowledge-intensive" firms and knowledge-intensive service activities (KISA). Knowledge-intensive firms rely heavily on qualified professionals (input). Knowledge-intensive service activities are defined in terms of competence supply (output). Knowledge intensive service activities are, however, not bound to the institutional settings of particular knowledge intensive firms or institutions. All firms and organisations, regardless of being perceived as knowledge intensive or not, to a various degree perform and make use of a set of knowledge intensive activities, provided internally and/or externally to the firm or organisation in question. This KISA project sets out to explore the functional perspective of knowledge intensive service activities. In this context, KISA should rather be seen in terms of the output of the knowledge intensive activities performed perceivably increased competences in the organisation and the development of enhanced innovative capabilities and innovation activity in the organisation in question.

There is a difference between competence supply, innovation and learning (ibid). A system analysed as an economy of competence-supply activities is not quite identical with a system

analysed as an innovation service system. Competence supply services are not necessarily innovation services and do not necessarily generate innovations in the client firm. They may, for example, be operational services, but performed by mobilising substantial competences rented from a supplier.

Competences are defined as abilities to do certain things in competitive settings. Included in the concept of competence are "shippable" aspects of science and technology-related services (such as configured equipment, prototypes, documents, software and platforms, i.e. embodied knowledge) and "performed" and interpreted elements of service and competence. Knowledge of the codified type, on the other hand is frequently viewed as "possessions" not embedded in a particular context and can be exchanged between contexts in unproblematic ways. Competences do not only support (manufactured) products. In the service economy competences may themselves be (service) products, competence development may in fact be product development.

On the difference between delivering and getting a competence

Cohen and Levinthal (1990) argue that "…the ability to evaluate and utilize outside knowledge is a function of the level of prior related knowledge… (which) confers an ability to recognize the value of new information, assimilate it, and apply it to commercial ends. These abilities collectively constitute what we call a firm's "absorptive capacity" (p. 128). According to Cohen and Levinthal research shows that firms that conduct their own R&D are better able to use externally available information.

Suppliers of competences may, however, not explicitly be selling innovation services. Innovation services may be tacit or informal as well as explicit, and may be provided as part of the business mix by suppliers whose majority business is production rather than development. In the KISA project it may be helpful to consider that all forms of "knowledge-intensive" production (manufacturing production as well as service production) may potentially be viewed as sources of competence, and thus as furnishing tacit or "bundled" innovation services.

3. The Norwegian aquaculture industry

This chapter will introduce the reader to the Norwegian aquaculture industry, by firstly presenting the major innovations in the industry, followed by a brief presentation of the laws and regulations that govern the aquaculture industry. The industry's main markets are presented, followed by a section looking into the value chain in aquaculture. Following this, we present data on employment and geographical distribution of aquaculture activity. We will also present data on developments in educational background in fish farming. Section 3.3 will briefly present the main actors in the innovation system of aquaculture, focusing especially on firm purchase of knowledge intensive service activities from Knowledge Intensive Business Services (KIBS).

Major innovations in the history of aquaculture

Fish farming and aquaculture is a relatively young industry in Norway. Its life spans no more than 4 decades, and the foundations of our present aquaculture industry is based on classical agricultural breeding programmes. Forty strains of salmon from all along the coast of Norway was the point of departure; eggs and milt from several strains of salmon were collected to create the genetic material for Norwegian farmed salmon (FHL 2003). Systemic breeding has crossed the most disease resistant strains of salmon, which have shown themselves to be capable of adapting to life in fish-farm sea-cage. Other preferred traits include rapid growth, colour, fat content and shape.

Berge (2000) in his work, has focused on the development of aquaculture in Norway, and describes three related innovations that shaped the technological fundament of the new industry. In essence, the changes were simple, in the sense that they were realized through practical experiments and trial and error, and not on the basis of science or advanced technology. Still, the innovations had major consequences, and stand out ex post as radical (Berge 2000, p. 160).

The first significant development occurred during the 1960s, when people engaged part time in rainbow trout farming decided to try to farm this fish in salt water. In spite of what appears to have been stern warnings from relevant experts in the Ministry of Agriculture, the experiments actually succeeded, and results were remarkable: The growth of the trout increased significantly as the fish was transferred to a salt water habitat (Berge 2000, 168-9).

The second innovation was successful breeding of Atlantic salmon. There was long standing experience with non-profit based production of salmon fry in leading salmon rivers. The new realization that it was possible to farm rainbow trout in seawater apparently spawned the idea that it ought to be possible to do salmon farming in sea water as an alternative to the farming of trout. In any case there were clear economic incentives for this focus on salmon: A big market demand for wild salmon and existing distribution and sales systems could secure sales of salmon at very good prices both in Norway and internationally (Berge 2000, p. 168).

A third and extremely important innovation was the transfer of salt water farming of fish from concrete dams on land into the sea itself. The pure bottom-up model of development that had marked the outset of aquaculture gradually was challenged by increased efforts from scientific milieus, from government agencies, and from the policy system to support the development of the industry, its knowledge base, and its governance system. As is seen from Olafsen's and Winther's analysis of the emergence of the fish farming industry

(Aslesen et al. 2002, pp. 5-8), six problem areas presented themselves in the efforts to scale up the commercial activities:

- **Process development** (Relevant problems concerned selecting the specific species most suitable for farming, finding locations, deciding what density of population that ought to be maintained, when and how to feed, etc.)
- **Equipment** (For example, closing nets had to be constructed and anchored adequately, to make them resist strong winds, to keep salmon from escaping, etc.)
- **Feed** (Concerns included how to make feed economical, but still providing nutrition for growth and health. Also, remains should not pollute the environment, etc.)
- **Health** (Sickness soon emerged as a key problem. Among the first key concerns of scientific research was to find effective remedies against parasites, bacterial and viral infections, deformities etc.)
- **Breeding** (First, the problem was posed as one concerning selection among natural species that were suited for farming, later efforts were concentrated on scientific breeding programs focussing on the development of different breeds from those found naturally)
- **Sales** (Key concerns were the expansion of distribution and sales systems, branding and development of marketing skills, the developing foreign markets, etc.)

Today, the aquaculture industry has reached the size and maturity where business can no longer be run efficiently merely by employing the ways and means that have been successful in the past. The industry is confronted with a series of new challenges. The strong demand experienced by the industry since its inception is no longer outpacing supply. The firms have increasingly experienced price pressures. At the same time, customer demands are becoming more differentiated, and not easily addressed.

Governance

Historically the regulation of aquaculture has played an important role in the development of Norwegian aquaculture (Jakobsen, Berge and Aarset, 2003). As the industry has grown in importance so has the governance of the industry. The political attention towards the industry has also grown the last years, both affecting the development of the framework conditions of the industry. We will in the following shortly describe some milestones in the governance of the industry.

1973: Introduction of The Fish Breeding Act – made permanent in 1981

Norwegian public administration of aquaculture has been build up around The Fish Breeding Act which is administered by the Ministry of Fisheries. Centrally in this law is the obligation to acquire a license for operating a fish farm. The duty to get official permission to operate a fish farm was established in 1973 (Oppdrettsloven; Law of breeding). This gives the licensee the exclusive right to operate a fish farm under specific conditions (FHL 2003). The different types of licenses related to salmon and trout are: Fish for food (matfisk), Parent fish, FoU (a licence for fish farmers for the purpose of experiments, research or instructions), Fry/fingerling[5]. By January 1, 2003, the authorities had issued 839 commercial permits for fish for food (matfisk anlegg) for salmon and trout.

1991: Ownership restriction in The Fish Breeding Act abolished

Until 1991 it was only permitted to have one license pr. company, and it was also required that the owner should be local. In 1991 the Fish Breeding Act was amended and the rules for ownership liberalized. This resulted in a sweeping restructuring of the industry. Acquisitions

[5] Fingerling is the name of the fish when it has started the assimilation. It is fed in the farm with the purpose of either to become fish for food or to be put in watercourses. Fry is the name of the fish during the period from hatching to the time it starts to assimilate nutrition (2-4 weeks).

and the concentration of ownership of licenses in the form of mergers resulted in increases in the value of licenses as well as bankruptcies.
In 2001 § 6 was changed again. The paragraph included that the Ministry could require compensation for awarding permits for the breeding of food fish of salmon and trout.

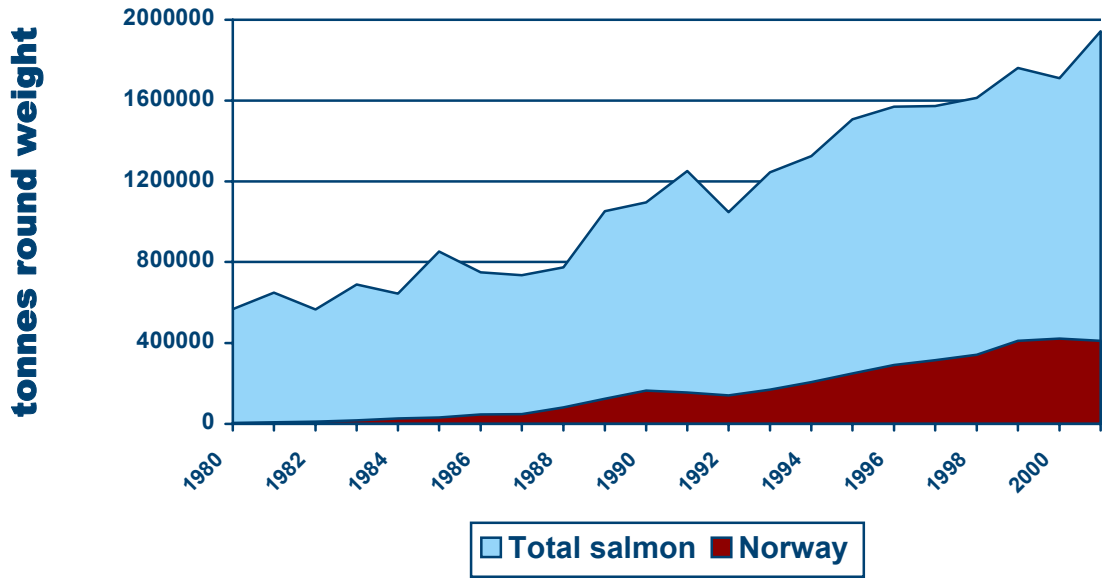
1996: Introduction of feed quotas
Salmon production is regulated by means of feed quotas, which is a method of controlling the growth of the industry. The amount of feed that each fish farmer can purchase is set by the Ministry of Fisheries on an annual basis. The aim of the feed quotas was to limit the growth in export to EU, and to hold the prices above a certain minimum price. As a mean to reduce production, the feed quotas have been effective, since the fish farmers only to a limited degree have the possibility to substitute fish feed. One effect of the feed quotas is a substitution effect towards rainbow trout, since it is only Atlantic salmon that is restricted by feed quotas. In 1995 the production of trout was estimated to 5,3 % of total production of salmon and trout, in 2001 the share was 14,0 % (Aarset et al., 2004). This might have regional implications in Norway since trout farming is concentrated to Vestlandet.
The sitting government intends to abolish the feed quotas from 1. January 2005.

1997: EU and Norway ratifies the Salmon agreement
The salmon agreement declares among other things the minimum price of salmon for the EU market. Against the background of accusations about dumping, the European Commission in 1996-97 decided to introduce a toll on Norwegian salmon of 14%.
The Salmon agreement is now abolished, but the exporter's price-agreements with the European Commission is still active until a new resolution is made.

Market developments and main customers

The Atlantic salmon is the driving force behind Norwegian Aquaculture industry and "Norwegian salmon" may well be Norway's best known export product. Salmon accounts for 32,2% of all exports of fish from Norway. In 2002 Norway exported nearly 500,000 tonnes of salmon and trout.

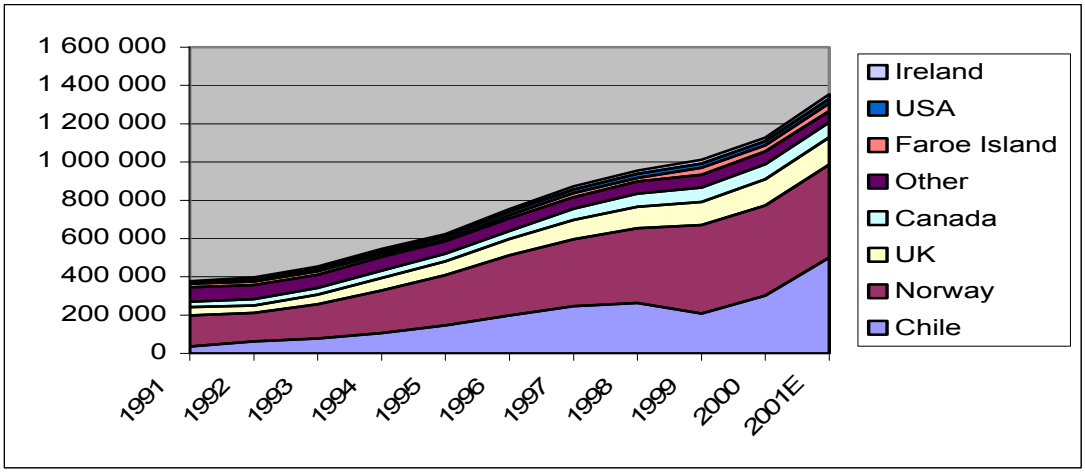
Figure 1. Norway's share of the total supply of salmon in the world from 1998 until 2001



Source: Norwegian Seafood Export Council

Norway has during the last 20 years increased its market shares in relation to the total supply of salmon in the world. However, in the last couple of years the Norwegian market share has diminished. Norway is experiencing competition from other countries with aquaculture activity. Nevertheless, Norway is still the largest producer of salmon in the world, but especially Chile has shown a strong growth the later years.

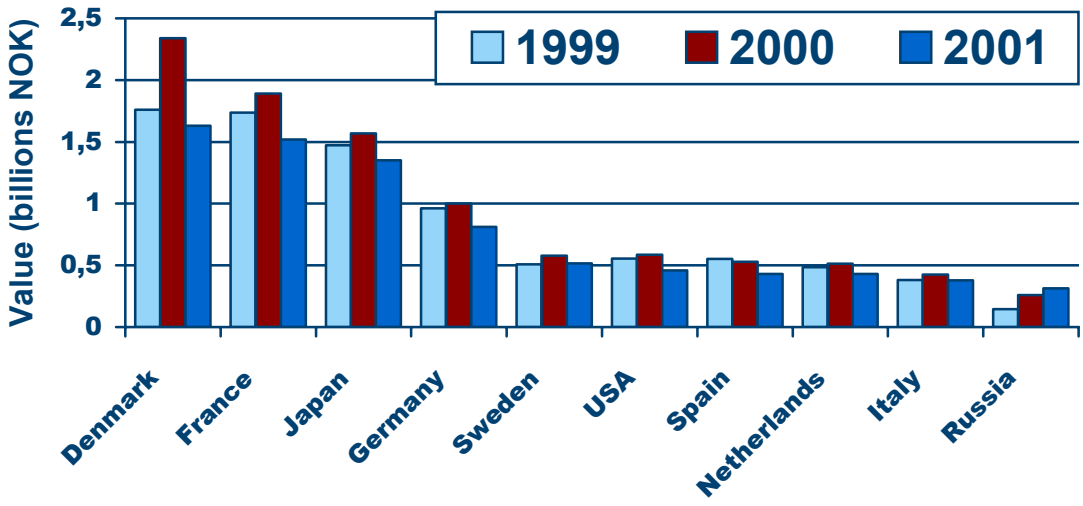
Figure 2. Production of salmon and large rainbow trout globally (1000 tonnes round weight)



Source: Kontali Analyse AS

Norway's share of the production of Atlantic salmon was 45% in 2001, the share in 1995 was 55 %. Looking at the joint production of salmon and large trout, Chile had a larger production than Norway in 2001.

Figure 3. The largest markets for Norwegian salmon 1999 - 2001



Source: Norwegian Seafood Export Council

Norway is primarily an exporter of primary fish products. This can be explained by several factors; traditions, trade barriers, and the high cost of production in Norway. In 2001 68% the export of salmon from Norway was fresh fish (Statistics Norway, Norwegian Seafood Export Council).

There has been an internationalization of the Norwegian fish farming companies over the last years. Norwegian companies have bought up whole or parts of fish farming companies

in other countries, especially in Scotland, The Faeroe Islands, USA and Chile. The Norwegian companies often place Norwegians in key positions in the new company. Norwegian acquisitions of companies today have more or less come to an end since the industry has been through an economic down turn the last years. However, one sees a growing tendency towards international enterprises in production, and food sale continues to grow.

Norway's market share in EU in 1993 and 2001 has dropped from 67% to 54%. However, when looking closer at the country of origin of these companies, one sees the decline in Norwegian market shares in EU is replaced with deliveries from Norwegian owned companies located in the UK, the Faroe Islands etc. (Norwegian Seafood Export Council).

Summing up

This sub-chapter has presented background information on the aquaculture industry. However, the industry must relate to changing conditions which put pressures on the internal organisation of the production establishments and on the functioning of the whole value chain of the industry. Such issues together with a series of governance changes implemented over the years have contributed to a pressure towards restructuring of the industry, and as a result a few very large firms have emerged on the basis of extensive processes of mergers and acquisitions.

The governance of the breeding of Atlantic Salmon has developed through the years, and the most important regulations towards the industry is the obligation to have a license for operating a fish farm, and further feed quotas to regulate production. However, there are continuous changes in the governance structure, the most recent being the possible abolishment of feed quotas in 2005.

Salmon is an important export industry for Norway, accounting for 1/3 of Norway's fish exports in 2002. The world market share is increasing, however, in the last couple of years other countries have taken the lead, especially Chile. Norway is primarily an exporter of primary fish products due to several factors such as traditions, trade barriers, and high costs of production. Norwegian fish farmers have internationalised the last years, and a larger share of fish is sold through daughter companies located abroad.

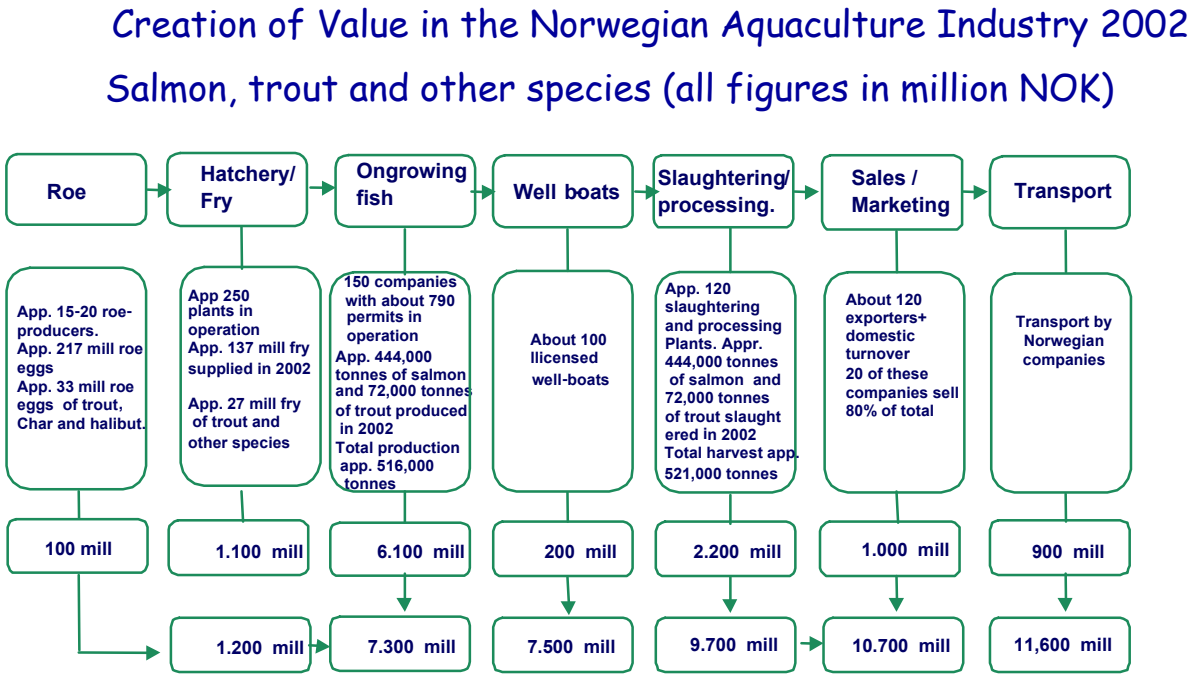
Value creation and activity in aquaculture

This section will firstly present in the value chain of aquaculture. Secondly, we will present the development of productivity in aquaculture, and thereafter focus on the actors in the industry. Lastly we will present data on the development of formal education among fish farmers.

Value creation

The figure below gives an overview of the core activities linked to fish farming and estimates the creation of value in each step of the value chain. The whole industry created value for 11.600 million NOK in 2002. In the following we will shortly describe the different activities that go into the value chain in farming of salmon, trout and other species.

Figure 4. Estimated creation of Value in Norwegian Aquaculture Industry 2002



Source: Kontali Analyse AS

Today there are between 15-20 roeproducers and approximately 250 fry plants in operation in Norway, contributing to 1.200 mill. NOK in value creation. However, the largest value creation is found in ongrowing fish (6.100 mill. NOK). 150 companies work in this segment of the value chain, responsible for producing a total of 516.000 tonnes of salmon and trout in 2002. In this part of the value chain, the fish is fed until it is slaughtered, usually at a size of 3-6 kg.

Well-boats are used to transport both smolt from the hatchery to the ongrowing farms, and fully grown live salmon from farms to the slaughterhouse. All the salmon is slaughtered in specialised fishprocessing plants. An important difference between Norway and other fish farming nations is the extensive use and development of well-boats. Today 100 licensed well-boats are drifted by 33 ship owners. During the last 5 years there has been a relatively large degree of reconditioning of the fleet. The fact that Norwegian fish farmers have used well-boats for transport of living fish changed the premises for optimal slaughter of the fish; fewer and more efficient slaughterers could be built. This can therefore be seen as an important process innovation in fish farming, an innovation also transferred to other countries were Norwegian fish farmers have activity.

In Norway there are approximately 120 slaughtering and processing plants for salmon and trout. The technology has its origin from traditional fishing industry, but is today specialised for salmon and trout. There is still much manual labour in the process, but continued innovations in machinery and equipment have reduced the need for manual labour over the last few years.

In Norway there are 120 exporters involved in the export of salmon and trout. The exporters can either be part of a vertically integrated company that is involved in fish farming, such as Pan Fish Sales AS, the company can act as exporter for several companies, such as NRS (Norwegian Royal Salmon), or they can be independent.

The exporter is the link in the value chain that has frequent contact with the market. They have close relationships to companies that import salmon and trout in other countries. At the same time they have relations to a broad set of actors in Norwegian aquaculture. The customers' needs and desires are often communicated through the exporter, and is therefore be an important messenger in relation to product innovation in fish farming.

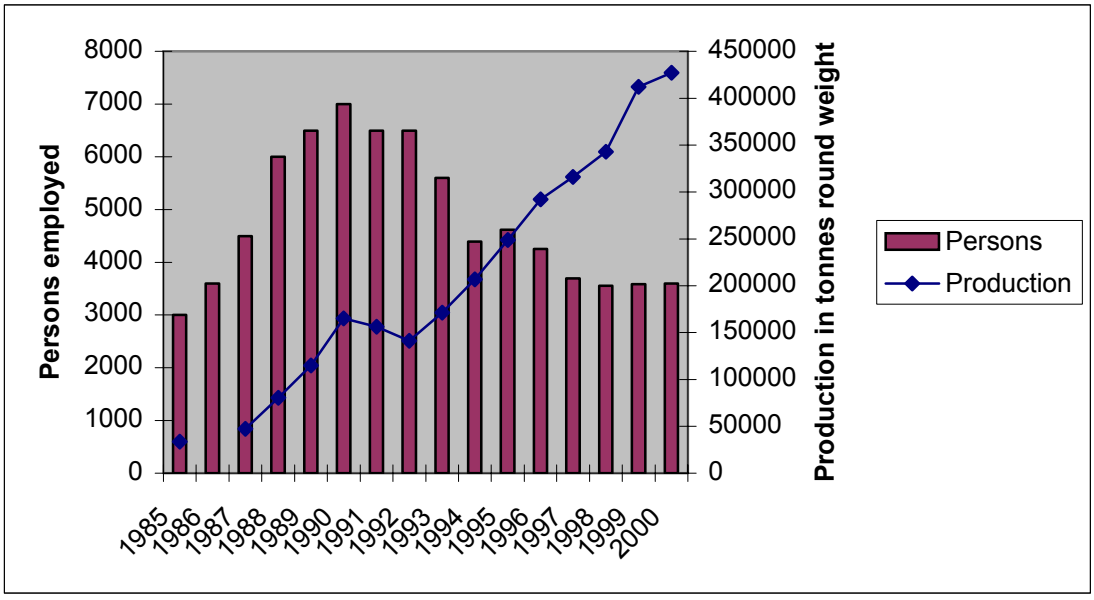
Every 20 minutes or so, every day of the year, a trailer of salmon crosses the Norwegian border on its way to the market (FHL). The largest share of export is by car, but boat, airplane and train is used. There has not been radical innovation in the field of transport the last few years. Therefore, there is still innovation potential in relation to the monitoring of and control of goods flows in the industry.

An analysis of spin-off effects from the fish farming industry (KPMG SINTEF, 2003) found that relatively speaking, every man-year in aquaculture in 1999 created 0,4 man-years of direct supply to the whole industry. For value creation (contribution to GDP) the number was the same, every NOK created in the aquaculture industry span-off 0,40 NOK in the supply industry.

Employment and productivity

Up until 1990 there was a steady increase in the number of employees in aquaculture. The peak was reached at 7000 persons in 1990. During the 1990s, however, there was a trend toward increasing efficiency in the production of farmed salmon and trout. This is illustrated in the figure below which shows an increased production per man-hour. The reduction of employees the first part of the 90`s can also be linked to the restructuring of the industry. The number of employees decreased steadily from 1990 to approximately 3500 persons in 1997/1998. The number of employees has now stabilised. In 2002 3457 persons was employed in the fish farming industry in Norway.

Figure 5. Employment in salmon and trout production and production in tonnes



Norway figures; 1985-2000, Source: Directorate of Fisheries /NFF

Fish-farming is a male-dominated occupation. In 1995 89,2% of the total number of hours spent in the production of salmon and trout was performed by men. In 2001 the male-share had increased to 90,6%.

Geographical distribution and concentration

Permits to carry out fish farming from 1981 and until today has been carried out through concession rounds (1981, 1983, 1985 and 2002, one extraordinary one for Nord-Troms og Finnmark in 1989). Based on the work carried out by Jakobsen, Berge and Aarset (2003) we will present the geographical distribution of licenses at the different concession rounds.

Table 1. Geographical distribution of licenses, by county and region

Norwegian counties (fylker)	1981	1982	1985	1989	2002
Finnmark	43	20	20	20	10
Troms		16	20	10	7
Nordland		16	30		7
N-Trøndelag		10	12		2
S- Trøndelag	11	6	10		2
Møre og Romsdal		8	13		3
Sogn og Fjordane		10	15		4
Hordaland		5	10		2
Rogaland		5	10		3
Skagerrak/andre		4	10		
Total	**54**	**100**	**150**	**30**	**40**

Source: NoU 1992:36, The Ministry of Fisheries press release no. 38/ 2002 (http://odin.dep.no/fid/norsk/aktuelt/pressem/008031-990034/index-dok000-b-n-a.html)

Production of trout and salmon has traditionally been concentrated to Western Norway and Trøndelag (mid-Norway). These areas were assigned a large number of concessions before the concession stop in 1997. As can be seen from the table above, the later concession rounds have favoured the Northern parts of Norway. In the new regulations it is decided that compensation is to be paid to the Government for new concession assignments, 4 mill. NOK for assignments in Nord-Troms and Finnmark and 5 mill. NOK for the rest of the country. It is hard to imagine the prevailing trade cycles, combined with compensation to the Government, will make it possible for young people to be able to finance new concessions. An important reason for establishing the obligation to acquire a license for fish farming was the wish to have local control with the industry. The licenses themselves have been sold for 10`s of millions of NOK. One effect of this is that it has been hard for newcomers to enter the industry.

*Table 2. The regional distribution of employment in aquaculture in 2001**

	1986	1990	1996	2001	%-share
Skagerrak/other	120	124	68	188	4,3
Rogaland	180	301	273	264	6,1
Hordaland	698	812	844	875	20,1
Sogn og Fjordane	442	460	403	336	7,7
Møre og Romsdal	481	658	675	463	10,6
Trøndelag	576	900	707	630	14,5
Nordland	668	673	733	798	18,3
Troms	256	345	398	506	11,6
Finnmark	103	231	164	290	6,7
Total	3 524	4 504	4265	4350	99,9

Source: Statistics Norway, Directorate of Fisheries

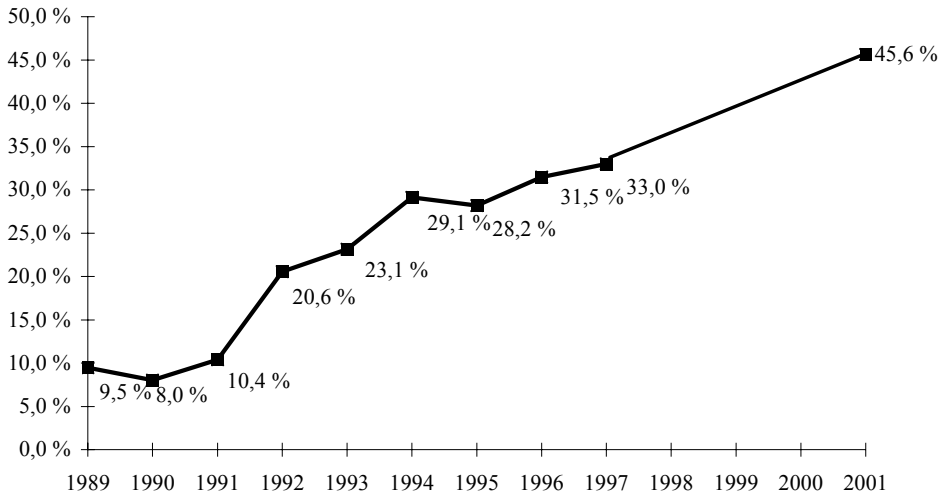
Note: * Includes both full-time and part-time workers.

The regional distribution of employment naturally follows the distribution of production. In 2001 Hordaland was the county employing the most people in aquaculture, followed by Nordland and Trøndelag.

A growing number of licenses for salmon and trout are owned by limited companies. In 2001 97,3% of fish food licenses were held by such entities. In 1992 this percentage was 86,3%. The share of salmon and trout licenses owned by sole proprietorships has seen the opposite trend. In 2001 only 1,2% of the licenses were held by such entities. In 1992 the corresponding percentage amounted to 6,7% (Statistics Norway, Fish farming 2001).

Another measure for the concentration within fish farming is the 10 largest production companies' share of total production of farmed salmon.

Figure 6. The 10 largest aquaculture companies' share of total production 1989 – 2001. Percentage.



Source: Jakobsen et al., 2003

As can be seen from the figure above, while the 10 largest companies in 1990 accounted for 8 % of total production, the share in 2001 was 46 %. The curve is especially steep from 1991 to 1992, a period with many bankruptcies in fish farming (Jakobsen et al., 2003).

There has been a tremendous growth among many of the largest fish farmers in Norway by the end of 1990 and the start of 2000, especially among companies like Pan Fish and Fjord Seafood. The earlier expansion in Hydro Seafood/Marine Harvest Norway, has stagnated.

Education and competence in aquaculture

Compared to other salmon producing countries, Norway was quick to build educational establishments supporting the industry. In 1994 reforms were carried out (Reform94) establishing specialised education in aquaculture and fisheries at secondary level. There are also specialised education at the university level (i.e. at Norwegian University of Agriculture, Norwegian College of Fisheries Science, University of Bergen, and Norwegian University for Science and Technology (NTNU)).

Most of these educational milieus have close relationships with research milieus supporting the industry with R&D services. For example the Norwegian College of Fisheries Science have close collaboration with the Norwegian Institute of Fisheries and Aquaculture Research and Norwegian University of Agriculture with AKVAFORSK. Many of the lecturers at these higher education institutions at the same time work as researchers in the institute sector.

Attitudes towards qualified labour in the seafood industry is studied by Reve og Jakobsen (2001) in their book ”Et verdiskapende Norge ”. Compared to other industries, only trading companies put less weight on skills upgrading than firms working in the seafood industry. In aquaculture 30% of the firms do not have a strategy for skills upgrading.

We will look into the educational structure of the sub sector “Operation of fish farms”, to get an understanding of the competence level of the industry and to see whether it has changed over a 10 years period.

Table 3. Educational background of employees in fish farming in 1992 and 2002

	1992	2002
	Operation of fish farms	Operation of fish farms
Unknown	0,8 %	3,0 %
Primary Education	74,0 %	47,6 %
Craft certified	0,4 %	1,0 %
Secondary Education	15,8 %	33,9 %
Other fields 1-4 yrs;	2,9 %	4,4 %
Other fields 5++ yrs;	0,3 %	0,4 %
Natural Sciences 1-4 yrs	1,9 %	3,8 %
Natural Sciences 5++ yrs	1,1 %	1,2 %
Econ 1-4 yrs	0,9 %	2,5 %
Econ 5++	0,1 %	0,1 %
Engin 1-4 yrs	0,7 %	0,9 %
Engin 5++	0,0 %	0,0 %
Medical 1-4 yrs	0,4 %	0,5 %
Medical 5++	0,5 %	0,6 %
TOTAL	100,0 %	100,0 %

Source: STEP based on the Firm and Enterprise Register, SSB

The most important change in educational background is the general increase in the educational level. The share of employees with primary education as the highest educational level has decreased by 26,4% in the 10 years period. Employees with secondary education as their highest education has increased from 1992 until 2002 with 18,1%. Further the table shows that the group of employees with 1-4 years of education from university has increased, especially in the field of “other fields”, “natural sciences” and “economy”, suggesting that the internal competence base of fish farmers has increased. Operation of fish farms is an activity carried out in the more peripheral areas of Norway. Regionalisation of higher education institutions has been an important regional policy over the last decades, and there has been great emphasis on the geographical spread of educational facilities for higher education.

Summing up

The aquaculture industry created value of 11.600 mill. NOK in 2002. Innovations and change has happened in all parts of the value chain over the years, making the industry continuously more efficient. In 2002 3457 person were employed in fish farming, half the number of employees in 1990. The production of salmon and trout has geographically been concentrated to Vestlandet and Trøndelag, the later concession round have favoured the Northern parts of the country. In 2001 the largest share of employees in aquaculture were found in the counties of Hordaland, Nordland and Trøndelag, making it an important industry in these costal counties.

There has been a consolidation in the industry in that a growing numbers of licences are owned by a limited number of companies. In 2001 the 10 largest companies accounted for 46% of total production.

In the ten years period from 1992-2002 the industry had a general increase in the education level. Both the number of employees with secondary education and employees with 1-4 years of education from university have grown (especially Natural Sciences).

Actors and activities supporting aquaculture

This subchapter will focus on some of the important actors that go into the aquaculture industries' innovation system. In the following we will shortly say something about the research activity linking up to aquaculture, the technology suppliers, and the feed producers. Lastly this subchapter will present the aquaculture industries' purchase of knowledge intensive services from the KIBS industry, by analysing Norwegian national accounts.

Research activity

The knowledge structure surrounding the aquaculture industry has been important for the development of the industry, especially in relation to combating diseases, to develop breeding, and fish feed. The enormous growth in the sector in the 90's had not been possible without this research effort. There are around 20 public, semi-public, and private research institutes in Norway that carry out research in relation to the aquaculture industry. They are clustered in four main areas of Norway, namely Northern Norway (Tromsø and Bodø), Mid Norway (Trondheim), Western Norway (Bergen and Stavanger) and Eastern Norway (Ås and Oslo). Research activity is very much directed at salmon species. The total expenditure in this area alone was in 2001 NOK 384,7 million, of which 45% was carried out by industry actors (Sundnes and Sarpebakken, 2003). The research activities carried out in public and semi-public research institutes today is more pro-active than earlier days. Further the research activities carried out could be characterized as "fire-fighting". An important research field today is research on fish feed, where the main objective is to optimize raw materials and feeding methods to produce a healthy, high-quality fish with a minimum use of raw materials. Public and semi-public research centres are predominantly publicly funded.

Technology and feed suppliers

Innovation is often a result of interactive learning processes between actors, and for aquaculture firms, feed suppliers and technology suppliers are important sources of new knowledge and technology. The decrease of employees in aquaculture has been followed by an increase in the number of employees in the supply industry (Aarset et al., 2004). The supply industry has developed new and better feed, advanced feeding systems, surveillance equipment, health- and veterinary services etc. Much of the innovation activity in aquaculture can be traced back to the supply industry.

An overview made by an interest organisation for the supply industry NLTH (Norske Leverandører til Havbruksnæringen) shows that the annual sales of suppliers of equipment to the aquaculture industry is approximately NOK 700 million, and they employ 850 persons.

The Norwegian fish feed industry consists of three large companies Skretting AS, Ewos AS, and Biomar AS. Since 1995 the number of feed suppliers in Norway has been drastically reduced. During the last years Nutreco, which is a supplier of feed to animals and fish feed

has made major acquisitions both in Scotland and in Norway. In Norway they bought up Hydro Seafood and became Norway's largest fish farmer, possibly making the link between the feed suppliers' R&D activity and fish farming more interconnected.

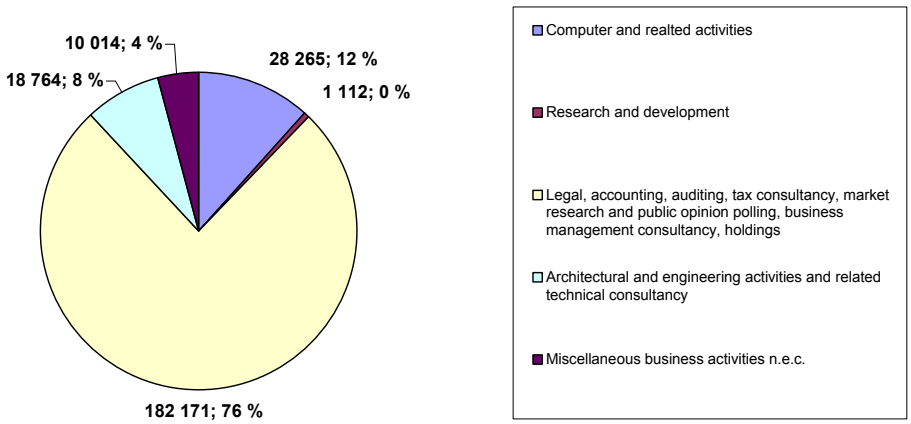
KIBS directed towards aquaculture

Based on a report by Aslesen and Olafsen (2003) the number of firms supplying the aquaculture industry with private knowledge intensive business services (KIBS) is approximately 60 companies representing sales of NOK 150 million, employing 200 employees (figures from 2002). The number of companies has increased over the last few years, whereas the number of employees has been relatively stable. A majority of the firms can be characterised as being rather small (from NOK 0-15 million in sales), having a large share of sales in the marine sector, with head offices in the coastal counties. Some of the larger KIBS also serve the marine sector, but their sales and activity towards this segment has decreased from 2000-2002.

The input-output data of the national accounts gives the opportunity to calculate the intermediate inputs from the KIBS sector into aquaculture. National accounts are divided into domestic input and output, reflecting the streams of goods and services traded between Norwegian sectors, as well as imports. The approach proposed in the KISA project is to take a functional perspective (on the actual knowledge-intensive service activities produced) to the analysis of the provision and use of KISA and not the institutional settings in which they are provided. However, using the institutional framework as a starting point will give us insight into an important dimension of KISA supply, and can tell us what kinds of KISA services demanded by the KIBS sector[6].

Of the aquaculture industries total national domestic input (purchase) the KIBS share accounted for 3,6% in 1999. The share has varied between 3,1% and 3,7% in the period from 1993-1999, with a slight positive development from 1993 until 1997.

Figure 7. Aquaculture's total domestic input from private KIBS in 1999. In 1000 NOK and percentage.

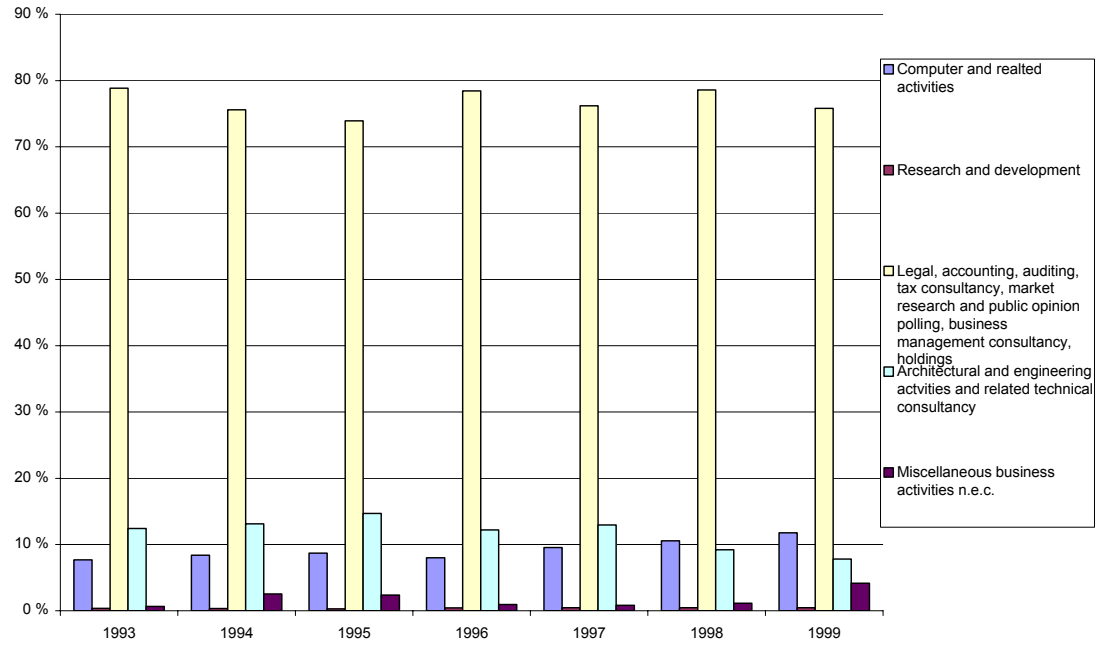


In 1999 the aquaculture sector's purchase of intermediate products from the KIBS sector amounted to approx. 240 million NOK. As can be seen from the figure above, activities related to "Legal, accounting, auditing, tax consultancy, market research and public opinion polling, business management consultancy, holdings" account for 76% of total KIBS purchase in 1999. The aquaculture industry has been through a turbulent period with

[6] Knowledge Intensive Business Services is here defined as NACE 72, 73, 741, 742 and 748. Aquaculture is defined as 05.20 "Operation of fish hatcheries and fish farms"

consolidations, mergers and acquisitions which possibly has lead to a demand for such knowledge intensive services as legal advice, management consultancy etc. This KIBS category also contains activities that firms "must" buy externally i.e. auditing. This category also includes "Holdings" meaning that purchase between units in the same holding company also can be registered in this category. The second largest KIBS category is "Computers and related activities" (12% of KIBS supply in 1999) followed by "Architectural and engineering activities and related technical consultancy" (8% of KIBS supply in 1999). The domestic purchase of R&D from the private market amounted to a bit more than 1 mill. NOK in 1999, and is a marginal activity compared to the other KIBS activities.

Figure 8. Share of KIBS purchase as share of total national purchase for aquaculture firms. 1993-1999.



The figure shows the different sub-categories of KIBS activities purchased by aquaculture firms in the period from 1993-1999. The most dominant change in the period is the increased share of purchase related to "Computer and related activities" which have increased from 8% in 1993 to 12% in 1999. The restructuring of the industry might have offset an increased demand for such activities in that internal reorganization demands new investments and upgrading of ICT. The productivity increase in the industry is also an effect of increased automation and use of ICT in production processes. "Architectural and engineering activities and related technical consultancy" has in the same period decreased from 15% in 1995 to 8% in 1999. Purchase of "Research and development" is hardly evident in the figure, and the share of total KIBS purchase in this category has not increased, but in nominal value there has been an increase from 1993 to 1999.

Summing up

Research activity in the public and semi-public institutions in Norway has been of great importance to the development of the aquaculture industry in Norway. The enormous growth and productivity gains experienced in the sector during the 90's would not have happened without this effort. Public funding provides more than half of the funding for aquaculture R&D conducted in Norway.

Other important innovation drivers in aquaculture are the technology suppliers and the feed suppliers. Much of the innovation activities going on in aquaculture firms can be traced back

to the supply industry. The KIBS industry is also used by aquaculture firms, however, their impact on innovation within aquaculture is still to be explored. However, when aquaculture firms purchase knowledge intensive services, it is mostly in the areas of “Legal, accounting, auditing, tax consultancy, market research and public opinion polling, business management consultancy, holdings”. There has been an increase in aquaculture firms’ purchase of knowledge intensive services linked to “Computer and related activities” in the period from 1993 until 1999.

4. The role of public policy*

Policy instruments targeting aquaculture firms

This chapter concentrates on government policies and programs for the aquaculture industry, with a particular focus on key industry-specific policies and programs enhancing the supply, quality, and demand of knowledge intensive service activities (KISA) in this industry. The main question to answer is whether government innovation policies have recognised and targeted KISA in the aquaculture industry, and supported their development. Therefore, we will identify the government measures that seek to influence the supply, demand, or quality of KISA, and investigate the scale and scope of the existing measures[7].

Norway has very few policies and programs directed particularly at KISA in aquaculture. Therefore we will also present some more general policies and innovation related programs open to all firms and see whether these include support for enhancing the supply, quality, or demand for knowledge intensive service activities in aquaculture firms.

The innovation policy system

At various levels the actors of the national system responsible for the shaping and execution of innovation policy, influence the innovation activity of the economy. By offering funding, counselling, advice, and networks the public (and some private/hybrid) innovation policy actors presented below in a variety of ways offer KISA services to innovating firms.

The national system for innovation policies in Norway consists of many actors. At the government level the responsibility for innovation and R&D is spread on a variety of ministries. Most ministries fund R&D but the main actors are:

- The Ministry of Education and Research
- The Ministry of Trade and Industry
- The Ministry of Local Government and Regional Development
- The Ministry of Health
- The Ministry of the Environment
- The Ministry of Defence
- The Ministry of Fisheries
- The Ministry of Agriculture

The Ministry of Education and Research, the Ministry of Trade and Industry and the Ministry of Local Government and Regional Development have the main responsibility of shaping national innovation policy. The shaping of the Norwegian R&D policy is based on the so called “sector principle” where each ministry is responsible for promoting and financing research and innovation activities within its respective area.

The Research Council of Norway (RCN)[8] has the superior responsibility for the national research strategy in Norway, and is administering almost one third of public research financing funds, and has over the years got increasingly more responsibility for the administration of research funds of the ministries.

* Some of the content in this chapter is based on Broch and Isaksen, 2004.

[7] The data in this paper is based on the web sites of the various agencies responsible for the policies or programs, phone calls to persons responsible for the programs, as well as the EU commission Trend Chart database for Innovation (www.cordis.lu/trendchart)

[8] www.forskningsradet.no

Innovation Norway. As of 1 January 2004 the new state owned company Innovation Norway has replaced the following four organisations: The Norwegian Tourist Board, The Norwegian Trade Council[9], The Norwegian Industrial and Regional Development Fund, (SND) and the Government Consultative Office for Inventors, SVO[10]. Innovation Norway promotes nationwide industrial development profitable to both the business economy and Norway's national economy, and helps release the potential of different districts and regions by contributing towards innovation, internationalisation, and promotion. The new state owned company employs more than 700 people. Innovation Norway has offices in all the Norwegian counties and in more than 30 countries worldwide. The head office is situated in Oslo. It is a central institution for public financing of industry and regional development in Norway. The most important financing ministries are the Ministry of Trade and Industry and the Ministry of Local Government and Regional Development.

Fishery and Aquaculture Industries' Research Fund (FHF)
FHF is the funding system for research and development in the fisheries and aquaculture industries. It is financed via a research levy of 0.3% of the value of exports of fish and fish products. The industries' own needs and interests form the basis of its R & D priorities. The primary task of the Fund is to identify research problems that the industry is interested in solving, and to consider how this may best be achieved. The Research Council of Norway and Innovation Norway are important partners.
www.fiskerifond.no

FHL Aquaculture:
(formerly, the Norwegian Fish Farmers' Association (NFF)).
This is an organisation for most people involved in Norwegian fish and shellfish farming. FHL Aquaculture takes care of the specific branch interests of its members and promotes their economic, professional, social and cultural interests. Its most important fields of activity are:

- industrial and commercial policy
- production and markets
- fish health
- environment and food safety
- coastal zone management
- research and development
- training and recruitment
- information and public opinion.

FHL Aquaculture's headquarters are in Trondheim and the organisation has three regional associations: Southern and Western Norway, Mid-Norway, and North Norway.
www.fhl.no **www.fiskeoppdrett.no**

SIVA – The Industrial Development Corporation of Norway[11] is a state-owned, but independently operating enterprise established to promote business opportunities and to increase employment. SIVA operates within three areas: real property, development activities, and investment/financing.

[9] The Norwegian Trade Council is a foundation promoting export of Norwegian goods and services to foreign markets. Offering counselling and advice the council assists firms and the Norwegian government regarding international technology cooperation.
[10] The Public Advisory Service for Inventors (SVO) is a public agency offering advice and scholarships for inventors. The office supports patent applications and building of proto types
[11] www.siva.no

Technological Institute (TI)[12] is a private foundation receiving public support to offer small and medium-sized firms relevant expertise to improve the knowledge, productivity, and profitability of Norwegian firms. TI offers counselling and development services, training, expertise and technology transfer programs, as well as laboratory testing and certifying services.

VINN – The counselling institute in Northern Norway [13]- is a private institute offering advice and contract research (hva er det – oppdragsforskning? Commissioned research?) within many technical and economic-administrative areas to firms in that part of the country. The foundation receives public support for parts of its activities.

A real estate based initiative within the innovation area in Norway is the **science parks**[14]. Traditionally the role of science parks was to act as service organisations and real estate administrators, but now they are more directed towards incubator activity and innovation assistance. Many of the science parks have their own commercialisation units or firms.

The foundation Norwegian Design Council[15] is financed by the Ministry of Trade and Industry. The council offers company advice and has its own projects. The main goal of the council is to promote the use of good design in market oriented product development and market communication of Norwegian firms.

KISA typologies of policy measures and government programs

The participants in the OECD KISA focus group have agreed on grouping the policy measures and government programs using the following categories:

1. Research and development programs and technologies for aquaculture
    - Research and development programs
    - Access to new technology
2. Infrastructure underpinning innovation capability
    - ICT innovation
    - Foresight
    - Knowledge and technology diffusion
3. Innovation capability in firms
    - Innovation management
4. Knowledge and mobility of human resources
    - Training
    - Inwards mobility
    - Industry associations
5. Standards and regulations
6. Global marketing and exporting
7. Intellectual property protection
8. SMEs: Entrepreneurship and development
    - Entrepreneurship
    - SME development
9. Commercialisation of new products

The specific focus of this mapping is to identify what sector-specific measures are enhancing the supply, quality, and demand for knowledge intensive service activities in aquaculture. Below we have shortly described programs targeting the aquaculture industry

[12] www.teknologisk.no
[13] www.vinn.no
[14] www.fin.no
[15] www.norskdesign.no

particularly according to the categorisation agreed upon by the KISA focus group. The main aim is too see whether central government in their overall policies have made some efforts to target renewal and improvement processes in the aquaculture industry by use of KISA.

1. Research and development programs and policies for aquaculture

The Research Council of Norway has been an important contributor to the development of the Norwegian aquaculture industry. Below we take a closer look into the various research programs possibly relevant for this case study of KISA in aquaculture:

HAVBRUK (aquaculture). The programme HAVBRUK in RCN is the programme most relevant to the aquaculture industry in the period from 2000-2005. The main aim of this programme is to secure and develop the theoretical foundation of market directed, environment- and resource production of aquatic organisms. The programme also aims at developing new knowledge on the breeding of marine species and other species through optimizing methods for production. Further the programme aims at obtaining professional knowledge on how to obtain commercial production of marine species, to secure quality of the product through the whole value chain, and to secure safe food production and environment for the animals, and to acquire knowledge which can give new business opportunities within aquaculture. The budget for 2004 is 64 mill. NOK.

There are also other programmes in RCN that are of relevance to the aquaculture industry, however, not entirely dedicated to the industry, such as the aquaculture programme. Many of these programmes are **user-driven R&D programs** of the Research Council of Norway. This means that they are based on the assumption that firms which are willing to take part in publicly financed R&D programs shall have decisive influence on the organisation, control, management, and implementation of relevant programs and projects. The idea behind the concept is that the firms are most suited to define business needs and that the companies to a greater degree will find possibilities for success and growth, however in close cooperation with universities, colleges and R&D-institutes.

Many of the programs presented below belong to the user-driven R&D programs. Most of the programmes are technological and/or biological in their orientation. Few of these programmes are directly linked to knowledge intensive service activities as mean to innovation.

FUGE (Functional genomics in Norway) was launched in 2002, and is a long-term plan for reorganising and restructuring Norwegian biotechnology research. The plan is a proposal for increasing the Norwegian research capacity in functional genomics in order to enhance basic biological research, medical research, and research in the marine sector. One objective is to enhance ties between the research community and trade and industry, and as such might help network aquaculture firms with KISA suppliers. FUGE request 300 million NOK annually in average over the 5-10 years.

Biot 2000 (Biotechnology 2000) is a research program that does not concentrate exclusively on marine issues, however a large part of the projects are relevant for marine issues and aquaculture. The programme includes projects from basic research to more applied research. The programme has been in operation since 1996 and will end in 2005.

MAROFF (Innovation program directed towards the maritime sector and offshore operations). The intent of this program is to secure sea transportation of passengers as well

as goods, and to see that the best transport alternatives with regard to efficiency, economy and milieu is taken into consideration. The program also have a focus on the aquaculture industry in that one of the research topics is related to improve production and sea transport of fish to contribute to value creation of Norwegian seafood. Besides focusing on transportation, the program has a focus on the use of business organisation and ICT in a globalised world, and as such directly focus on knowledge intensive services. The program started up in 2002 and will end in 2009. In 2004 the budget is 28 million NOK.

MARKSAM (Market and society). The program intent to strengthen the foundation of social sciences in support of resource and environment governance, industry development together with production, distribution and sales of goods and services within fisheries and aquaculture, farming, forestry and outlying field production. The program shall strengthen market competence for these industries and for public government. The program also aims at raising the competence within fields and disciplines serving these research needs, create meeting places for researchers and users and actively mediate research results to public administration and users. The duration of the programme is five years, from 2000-2005, with a budget for 2005 of NOK 48 million. The programme is one of the very few programmes that have a special focus on KISA with relevance to the aquaculture industry.

Branch oriented IT (BIT) started up in 1989. From the start the main goal of the program was to increase the competitiveness and profitability of small and medium sized businesses, through the development and implementation of common IT solutions at branch levels through close cooperation between branch organisations and suppliers. Gradually the focus has turned more towards electronic business. The goal of BIT is to contribute to internal electronic business in value chains to increase the competitiveness of SMEs. Therefore an important aim is the spread of solutions in individual branches. The BIT program follows a business driven cooperation model including e-solutions in value chains, as well as tools for effective use of ICT at the firm level.

The program supports ICT providers in their role as intermediaries for innovation in client firms, acting as KISA suppliers. The BIT program comprises the development of integrated ICT solutions adapted to firms in particular business sectors. Through competence and organisational development, effective use of new ICT solutions should be obtained. Software suppliers provide relevant core competences and knowledge (KISA activities) into the BIT projects. The software provider enhances the user firms' absorptive capacities for the new ICT based solution. The BIT program therefore targets both the supply of and the demand for KISA.

Innovation Norway administers the BIT program. In 2002 the budget was NOK 25 million. Innovation Norway cooperates with branch organisations, pilot firms, and software suppliers in this program. The branch organisations coordinate the activities vis-à-vis the relevant branches. The pilot firms develop new IT solutions to be implemented by other firms in the relevant branch.

Former SND attempts to measure the effects of BIT, performed in 2001, show a very good spread of IT solutions in the branches that have finished the development of branch solutions. Good effects have also been obtained in the pilot firms. The measurements show both rationalizing effects and strategic effects. The rationalizing effects include better basic data and routines, better control of production and logistics, as well as better statistics and prognosis. The strategic effects include better marketing, customer service, and continuous competence increase.

The program period of the **ICT program** is from 2001 to 2008. The program addresses the Norwegian ICT sector as such but is also focussing on the promotion of innovative and efficient use of ICT in business and social life in general. The program therefore indirectly supports both the supply of and demand for KISA. The ICT program stimulates the interaction between leading technology environments and innovative users. The target groups of the program are to be found where ICT is a central technology to realise products and services, primarily firms within electronics, instrumentation and measurement techniques, software, telecommunication, micro technology, net(work) based services, as well as multimedia and language technology. Reflecting the structure of the ICT sector the program addresses and services SMEs and entrepreneurs. The program supports cooperation amongst SMEs, cooperation between SMEs and knowledge environments, and between SMEs and larger companies.

The ICT program supports R&D projects with considerable technological risk and correspondingly high potential for value creation, but also considers project support if necessary to obtain satisfactory technology diffusion and collaboration in a sector characterized by many small units. Particular focus is put on projects involving start-ups and projects where an international R&D cooperation is a central element. The program is administered by the Research Council of Norway and had a budget of NOK 60 million in 2002.

The **IT Funk program** started up in 1989. The superior objective of the program is to increase physically disabled people's accessibility to new technology, and through this to increase their accessibility to the society in general. To reach this goal IT Funk contributes to the development and diffusion of effective methods and tools for research, development, and the introduction of IT-based solutions available and useful for people with various kinds of handicaps. The program therefore supports the supply of KISA. IT Funk will promote companies' development and delivery of IT solutions available to all, supplemented by special solutions for disabled if necessary. IT Funk is administered jointly by RCN and Innovation Norway and has a program period from 2002 to 2006. The budget from 2001 was NOK 6, 5 million.

The **PULS program - Services, Commerce and Logistics** aims to be an important factor in the development of a competitive service industry in Norway in general. The program is not focused on the ICT sector as such but supports general R&D based innovation and innovation processes in networks of cooperating service firms, as well as the development of better and more efficient logistics and transport services, competence development, and internationalisation. The program is administered by the Research council of Norway and has a program period going from 2002 to 2010. The budget of 2002 was NOK 45, 7 million. This programme is of special relevance to aquaculture firms in that they export large amounts of fish daily, and that the market continuously demands better quality and fresh fish. The challenge is to make aquaculture firms parts of this programme.

OFU ("Public Research and Development Contracts"[16]) started up in 1968. The OFU scheme is a subsidy measure administered by Innovation Norway, where the role of Innovation Norway is to relieve the risk of R&D in firms and to act as releasing agent of an OFU project. The OFU measure is not focused on the ICT sector as such but gives Norwegian businesses, in general, unique opportunities to cooperate with various public

[16] In Norwegian: "Offentlige Forsknings- og Utviklingskontrakter", OFU

departments in order to develop as a supplier in society. The result of the contract may give the firm increased market access within the public sector nationally and internationally. On the other side by active use of OFU contracts the public sector may contribute to build up the product spectre and technical competence of Norwegian firms. Additionally the scheme is to contribute to make public administration more effective.

An OFU contract is a binding contract between a public department and a Norwegian firm where the firm undertakes to develop and deliver a new product or solution to the department. An assumption in the OFU program is that there should be a public procurement need that cannot be met in a satisfactory way through existing solutions. The product or solution must be developed and produced in Norway. In 2001 the total budget of the OFU scheme was NOK 96 million.

The **IFU** scheme ("Industrial Research and Development Contracts"[17]) is a targeted subsidy measure for the development of SMEs as suppliers for larger firms localised within or outside Norway. The scheme stimulates close development cooperation between a demanding customer firm and one or more supplier firms. The advantages of such cooperation for the supplier firm is increased competence, access to a larger market and networks, as well as obtaining a solid reference. For the customer firm the access to specialised competence and lower development costs may be some of the advantages.

Like the OFU contract the IFU contract is a binding contract, however the contract is made between two firms. The supplier firm is to develop a product, a process, or a service needed by one or both parts. A prerequisite of the IFU program is that the supplier firm(s) is a SME (less than 250 employees) and larger firms cannot own more than 25 of these SMEs. The cooperation as such should be based on developing a new business relation between the partners. The product, process, or service developed should represent a substantial effort within its product area, and a market beyond the pilot customer should be made probable.

The public authorities support for an IFU project is maximum 35 % of the project costs and maximum NOK 3 million per year. In 2001 the budget of the IFU scheme was NOK 80 million. For 2000 former SND states that for both the OFU and the IFU measures together the total amount of funding for the ICT sector in particular was NOK 43, 9 million.

The OFU and the IFU schemes were evaluated in 2000[18] and the evaluation concluded that the measures had been successful in light of obtaining its basic objectives and to secure value for money. This general positive assessment should be seen in connection with particular aspects of these measures, including the specific participant profile of the measures (what kinds of firms participating in the schemes) and changes in the portfolio firms over time.

The generic taxation scheme **SkatteFUNN** is a general tax incentive for all companies with the objective of stimulating an increase in R&D investments in the business sector in its present form. Companies may deduct costs of investments in in-house R&D as well as R&D commissioned from R&D institutions; however applications must be accepted by the Research Council of Norway in advance. SMEs (companies with less than 250 employees)

[17] In Norwegian: "Industrielle Forsknings- og Utviklingskontrakter", IFU
[18] Staude M. et al (2000) "Til beste for de beste – En evaluering av offentlige og industrielle forsknings- og utviklingskontrakter" ("To the best for the best – An evaluation of public and industrial research and development contracts"), STEP-report R-02/2000, Oslo

get a tax reduction of 20 % of total project costs. Applicants owned by 25 or more by companies larger than 250 employees as well as companies larger than 250 employees themselves get a tax deduction of 18**.**

2. Infrastructure underpinning innovation capability

There are no particular programs aiming at infrastructure underpinning innovation capability in the aquaculture industry alone. The programs presented below are generic programs open to all industries.

HØYKOM is a grant-based scheme for developing broadband communications. The program has a program period from 2002 to 2004. The budget of the program for 2002 was NOK 53, 5 million. The main objective of HØYKOM is to stimulate the use of services and content requiring broad band, as well as strengthen the competence related to broadband. The grants are to support learning about the use of broadband, to develop effective guidance services, to exploit information networks, to communicate experience, and to make possibilities visible. The target groups of the program are diverse, but there is a particular focus on the health sector, and regional and local public administration and services in general. It is a wish that colleges, consultancies, and other competence environments in a direct and indirect way will contribute to the initiatives of the program. An adjacent program, HØYKOM School (budget in 2002 was NOK 48 million), has partly overlapping target groups with HØYKOM, but focuses more on stimulating the development of broad band in schools. Regarding content and service production other actors may apply for grants, e.g. cooperation constellations between companies and public actors. This programme is also of relevance to aquaculture firms in that they are located in peripheral areas and need to have close contact with external markets, suppliers etc. to be able to carry out their business properly.

Due to lack of available private capital the first of the regional **Seed Capital Funds** (Såkornfondene)[19] were established jointly by the Ministry of Trade and Industry and former SND in 1997. The seed capital funds (now 5 funds) are fully privately owned funds. The government invests risk capital by contributing 50 % of the capital base of the funded companies by providing liable loans through Innovation Norway. Innovation Norway follows up the liable loans and acts as a coordinator and network builder. Additionally Innovation Norway is represented in the boards of the seed capital funds. The objective of the seed capital instrument is to be able to enter innovation projects in an early phase with owner capital, competence, and networks. The capital base of each regional seed capital funds is NOK 100 million[20]. Additionally the regional funds have a loss fund of NOK 12, 5 million.

Norway also has a national seed capital fund called the **START fund** ASA, starting up in 1998. The START fund is a private company with 18 private shareholders belonging to considerable business and financial networks. The goal of the START fund was through long-term ownership to develop the portfolio companies into international winners. The START fund targets knowledge and technology based firms with a unique business concept and potential for international growth. The fund focus particularly on firms within areas characterised by major structural changes or within areas with great technological dynamics, e.g. within the convergence technologies of internet/telecommunication and within the life

[19] The five seed capital funds are: Såkorninvest Innlandet, Såkorninvest Sør, SåkorninVest, Såkorninvest Midt-Norge and SINAS – Såkorninvest Nord AS.
[20] The exception is the Såkorninvest Innlandet which has NOK 60 million in capital base.

sciences. Innovation Norway offers NOK 160 million in liable loans to the funded companies. The START fund has a capital base of NOK 320 million.

Foresight- aquaculture 2020
Innovation and business development can profit from scientific research, and the efforts to carry out fundamental scientific investigations can profit, and even depend fundamentally on, advances made in technology and practical knowledge. However, in the day-to-day operations of an innovation system there is no easy match between advancing disciplinary knowledge and developing cost effective knowledge-based solutions to commercially relevant problems. In day-to-day work, science and business activities tend to become disparate and lacking in real, and for both parties potentially very useful, interaction.

In order to promote such interaction in Norwegian aquaculture the Norwegian Research Council during 2003 and 2004 initiate a foresight process in which competent representatives of the aquaculture and related fields engaged in a creative process of looking towards the future, trying to assess what kind of developments aquaculture face the next few decades. People from business, government, and academic life became engaged in a dialogue, where the basic idea was to develop common perspectives on what the future could hold. During the process, a number of creative ides emerged, and the overall sentiment of the people involved with respect to the development of aquaculture, led to the formulation of five different scenarios for the state of Norwegian aquaculture in 2020. On the basis of these, several challenges relevant for policy makers and for people in the industry have been identified, and a long list of topics for relevant future research has been compiled.

Knowledge and technology diffusion
Most innovation related programs in Norway have knowledge diffusion as one important objective. However, there are no programs or schemes directed solely at the diffusion of knowledge or technology within aquaculture.

3. Innovation capability in firms

Innovation management
The FRAM program started up in 1992 and the present program period of the program runs until 2005. The program is administered by Innovation Norway. In 2002 the program had a budget of about NOK 40 million.

FRAM supports basic learning in SMEs (firms with 1-30 employees), particularly within the areas of management and building up of company strategies with the objective of making the firms more competitive. The goal of the program is a profitability improvement of last year's operating revenues in 75 % of the participating firms. The program explicitly targets managers of SMEs.

In the early 1990s the Research Council of Norway had great success with a program called BUNT, a technology driven program targeting firms' abilities to find and use new technology developed in other companies or research institutions. However, the focus of the BUNT program became increasingly directed at management training than the direct use of science and technology, and the former SND was given the task of developing a follow-up program, the FRAM program.

The FRAM program starts up with an analysis of the present situation in the company. The analysis is then used as a basis for developing a strategic action plan consisting of activities

for the firm to accomplish during the 15 months program duration. Between 8 and 10 firms in the same region meet 6 times to discuss results and experiences within all areas of the value chain, but with a particular focus on management. Between these meetings particular consultants with management experience follow up the defined company activities.

In 1997 the **FRAM program** was evaluated[21], and the evaluation showed that many firms reached the goal of profitability improvement, and that many firms reported to have achieved increased knowledge and competence. However, the profitability improvement did not differ from a control group of firms not participating in the program. Nevertheless the evaluation recommended extending the FRAM program because other studies showed that there was a need for the development of strategic thinking and company management in firms. The FRAM program was mentioned several times in interviews with aquaculture firms, and seemed to be an important program with relation to the use of KISA internally, and to build networks to KISA providers of relevance to the industry.

The **ENT program** - Establishment with New Technology started up in 1991. Technological Institute (TI) takes care of the practical administration of the ENT program and TI employees function as consultants for the participating companies. Innovation Norway, however, is responsible for application approval. In 2001 ENT had a budget of about NOK 8 million. To reduce the risk of entrepreneurs the ENT program offers start-up companies financial support in terms of counselling. The entrepreneurs receive advice in the early development phase of products, processes, or ideas.

Another innovation management and technology program focusing particularly on the region of Northern Norway – **The NT-program** – started up in 1987. The most recent program period ran from 2000 to 2003. The NT-program supports innovation in this part of Norway by obtaining capital, give advice and develop company networks and knowledge institutions. The NT-program is administered by Innovation Norway and the budget for 2002 was NOK 24 million. There is no particular focus on ICT companies but the main objective of the program is to make new and already existing technology based firms more innovative. Several evaluations have been undertaken regarding the NT-program, the main conclusion from the last evaluation, representative for the conclusions of the previous evaluations, is that there is an evident need for a selective instrument in this part of Norway.

The **MOBI program** – "Mobilising R&D related innovation", itself being an umbrella program for several other programs[22]. MOBI started up in 2001 succeeding the previous BRO program. The program period of MOBI runs until 2009. The main objective of MOBI is to promote learning, innovation, and value creation in companies. Many firms experience barriers to innovation, e.g. too high risk, lack of relevant expertise, and knowledge about where such expertise may be found, as well as lack of capital, and MOBIs ambition is to reduce the number of barriers and the effects of these. The main strategy of MOBI is to carry out programs and R&D projects focussing on the interaction between industry, R&D environments, and innovation political institutions as well as regional innovation. The total budget of MOBI for 2002 was NOK 52, 3 million.

[21] Nesheim, T. et al (1997) Evaluation of the FRAM program in SND, SNF report 84/97, Bergen
[22] NHS Næringsrettet høyskolesatsing (Industry oriented advanced college-based initiatives), TEFT (Technology communication from research institutes to SMEs) and finally ARENA-Regional Innovation Pilots (common commitment between the Research Council of Norway and SND).

Another user-oriented program, **Value creation 2010 (VS 2010) –** "Company development through broad involvement", is a cooperation program between the Research Council of Norway, the Norwegian Federation of Trade Unions (LO), the Confederation of Norwegian Business and Industry (NHO), and Innovation Norway with the program period running from 2001 to 2010. The Research Council of Norway has the administrative responsibility of the program. The main objective of VS 2010 is to increase value creation in the industry in general, not just the ICT sector, through stimulation of company cooperation with research institutions in relation to organisational development, innovation, and renewal activity. An important focus is that employees must be involved at a broad scale in the learning, development, and innovation activities of firms. The budget of VS 2010 in 2002 was NOK 21,3 million.

4. Knowledge and mobility of human resources

There are no particular policies or programs targeting knowledge or mobility of human resources in firms in general to aquaculture firms Norway.

5. Standards and regulations

There are no particular policies or programs targeting standards and regulations in the aquaculture industry. However, standards and regulations are developed through knowledge generation and results of R&D projects carried out in many different programmes. Such results often create implications for policy, and as such feeds into the knowledge based processes between policy makers and representatives from industry etc., which creates standards and regulations in specific industries. Valuable KISA from a broad set of actors are important input to the creation of standards and regulations in the aquaculture industry.

6. Global marketing and exporting

Norwegian Seafood Export Council (NSEC). NSEC is the Norwegian seafood industry's combined marketing and information council, and is the joint marketing body for the fishing and aquaculture industries. Its primary aim is to increase awareness of and interest in Norwegian seafood in Norway and throughout the world. The Council is financed by the industry itself via a levy on exports of Norwegian seafood.

The Norwegian Seafood Export Council was established by the Storting (Norwegian Parliament) on 1 July 1991, and its activities are founded in the Fish Export Act. The Council attends to administrative functions and is an advisor to the Ministry of Fisheries. Approval of exporters, dissemination of information to the industry, and joint marketing of Norwegian seafood on both national and international levels are tasks imposed upon NSEC through legislation. NSECs activities are concentrated in four product areas: Marketing, market information and market access, and public relations.

The objective of **the International Technology Cooperation** scheme administered by the Trade Council of Norway, is to strengthen the international competitiveness of Norwegian firms, by stimulating technology transfer from abroad, mapping the marketing possibilities for technology developed in Norway, and establishing networks and alliances between Norwegian and foreign firms. The target groups are various public institutions, universities, and other research institutions as well as firms. The budget of the international technology cooperation program in 2002 was NOK 20,5 million.

The Trade Council of Norway offers an Export and technology program for small and medium sized companies called **the SME program**. The objective of the SME program is to

promote growth in SMEs, preferably R&D intensive companies with a potential to succeed in international markets. The program had a budget of about NOK 17 million in 2002. Through advisory services and assistance in the fields of marketing and technology, SMEs should be enabled to enter into new international markets, introducing new products in existing foreign markets, or entering into marketing or technology development partnerships abroad. The program is, however, in the process of being phased out.

The Entrepreneurship program also administered by The Norwegian Trade Council focuses on innovation, renewal activities, and technology development. The objective of the program is to contribute to a successful *internationalisation* process of newly established and innovating firms in general. The entrepreneurship program is to contribute to the commercialisation of the products of these firms. There is much focus on the input of export competence and market knowledge to the firms. The budget of the entrepreneurship program in 2002 was around NOK 12 million.

7. Intellectual Property Protection

There are no particular programs targeting intellectual property protection

8. SMEs: Entrepreneurship and development

Entrepreneurship

The Incubator program started up in 2000 and is administered by SIVA (Selskapet for Industrivekst) – The Industrial Development Corporation of Norway. The objective of the program is to stimulate the establishment of new companies with growth potential, and by this contribute to the development of strong regional and local environments for value creation.

An incubator is a development environment for firms in the start-up phase located inside an established competence centre. The incubator offers the start-up firms physical premises, technical infrastructure, counselling, and advice regarding company start-up. Additionally the incubators allow firms admission to a wider network of competence and services, e.g. R&D institutions. Each incubator gets an annual grant from SIVA of NOK 800 000. The total budget of the incubator program in 2002 was NOK 20, 5 million.

In addition to the Incubator program an **Incubator grant** scheme was started up in 2001 and is administered by Innovation Norway. The main objective of the Incubator grant is to stimulate increased establishment of competitive, future oriented, and innovative firms contributing to innovation and business renewal. The grant is reserved start-ups with a high knowledge- and technology level expected to have a large potential for value creation, a high degree of risk as well as offering products or services with a potential for introduction in international markets. The incubator grant includes financial support, follow-up of the companies, and training. The incubator grant will only be granted persons or firms in an incubator, but belonging to an incubator does not necessarily give the right to incubator grant. The budget of the incubator grant in 2002 was NOK 19 million.

See also the Entrepreneurship program administered by The Norwegian Trade Council (under the category Global Marketing and Exporting)

SME Development

See also the SME program above also administered by The Norwegian Trade Council (under the category Global Marketing and Exporting).

9. Commercialisation of new products

The research based innovation program – **FORNY** – started up in 1994 and the current program period goes until 2010. FORNY is a joint effort of Innovation Norway and the Research Council of Norway regarding national and regional innovation systems, and is particularly directed towards not-yet-born companies. The program addresses both R&D environments, firms with R&D activities, as well as public enterprises with R&D activities. The main objective of FORNY is to increase the value creation by commercialising knowledge intensive business ideas with great potential. The goal is to refine R&D results to commercial activity. The most important instruments of FORNY are stimulation of ideas, commercialisation assistance, and early capital. The budget of FORNY in 2001 was NOK 45,5 million.

See also the Entrepreneurship program administered by The Norwegian Trade Council (under the category Global Marketing and Exporting).

Summing up

In this chapter we have focused on agencies and measures targeting the supply, quality, and demand for knowledge intensive services in Norway relevant to the aquaculture industry in Norway. In general there are few policies targeting the aquaculture industry directly, and even less focus is put on policies directed particularly at the supply, quality, and demand for KISA in aquaculture in particular. Most of the programmes have a focus on technology and biology; few programmes have a focus on services role as innovation booster.

However, going through programmes of relevance to aquaculture firms one sees that many could be useful for the development of different aspects of supply, demand, and networking of KISA in relation to aquaculture firms. Some of the more generic programmes, such as PULS, Høykom, and especially FRAM are highly relevant. However, in interviews with representatives from RCN, the challenge seems rather to make small aquaculture firms actually to take part in the different programmes and projects of relevance to them.

5. Characteristics of innovation in the aquaculture industry

The main aim of this project is to look into how knowledge-intensive service activities play a role in developing capabilities to innovate in aquaculture firms. This chapter will present data in order to understand the main characteristics of innovation in aquaculture. Further, the chapter will elaborate on what aquaculture firms perceive to be important input into their innovation processes. Aquaculture firms' innovating strategy can indicate what kinds of competence they see as valuable in relation to innovation, and thereof what kinds of internal and external knowledge intensive service activities that can trigger innovation.

This chapter presents innovation studies in aquaculture based on different sources. Firstly, we will present innovation statistics mainly based on the Norwegian part of the Community Innovation Survey from 2001. To be able to inform government policy and programs on how aquaculture firms might use KISA in their innovation building capability, we will further present a qualitative study of aquaculture firms that differentiates aquaculture firms' innovation strategies (Aslesen et al. 2002). In the second part, we will present a model of four different innovation strategies used by aquaculture firms.

Innovation activity in aquaculture

This section will present innovation statistics based on findings from the Norwegian part of the Community Innovation Survey[23] (CIS) of 2001. This survey has been conducted two times earlier in Norway (1992 and 1997). The sample of the 2001 survey was 3899 firms representing 11832 firms in the population. Throughout this study, the weighted data from the CIS survey will be presented.

The main questions to be answered in this section are:

- What is the level of innovation and what are the different types of innovations in aquaculture?
- Where do aquaculture firms get ideas and inputs for their innovation activities (e.g. from external KISA provision) and who do they collaborate with in relation to innovation (external KISA)?
- What factors are seen as barriers to innovation in firms?
- How do firms finance innovation activity?

The Community Innovation Survey from 2001 collected data from 41 firms in aquaculture[24], representing 110 firms in the population. Since the sample number is relatively low, one must be careful in generalising from the reported findings, and rather use the results as indication and examples of how innovation in aquaculture firms is carried out.

Innovation activity

In the CIS survey innovation activity is rather strictly defined as having successfully introduced new or substantially improved products, processes, services, or methods to produce or deliver these services.

[23] The Norwegian part of the Eurostat Community Innovation Survey (CIS) is performed by Statistics Norway. The unit of the CIS is the enterprise. The survey is conducted as a representative sample survey of all enterprises with more than 10 employees, combined with a full scale count of all enterprises with more than 100 employees. All industries, a selection of service sectors as well as for building and construction, electricity and water supply, oil and gas, mining and finally fish farming are included in the CIS survey. The enterprises are obliged to report, so that lack of responses is a very marginal problem. All numbers are scaled up to represent the whole population of enterprises represented in the industries concerning branch categorisation and size categories covered by the survey (weighted).

[24] Nace 05021 and 05022.

Table 4. Share of innovating firms in all industries and in aquaculture, 2001

	All firms			Aquaculture		
	Total	Non-innovating firms	Innovating firms	Total	Non-innovating firms	Innovating firms
Sample	3899	2378	1521	41	25	16
Population	11832	8427	3405	110	68	42
Share of population	100,0%	71.2 %	28.8 %	100 %	61.7 %	38.3 %

Source: Community Innovation Survey for Norway 2001

In 2001 only 28,8% of the firms in the population report to have introduced new or substantially improved products, processes, services, or methods to produce or deliver these services in the period from 1999-2001. In aquaculture the share is close to 10 percentage points higher, 38,3%, suggesting that the share of innovative firms in the sample of aquaculture firms is above average of all firms in the survey.

Table 5. Innovative firms, innovations new to the market 1999-2001

	2001		
	Manufacturing[25]	Services	Aquaculture[26]
N	885	521	14
Total	1749	1444	36
Share of total	40,7 %	46,3 %	35,0 %
N valid	885	521	14

Source: Community Innovation Survey for Norway 2001

Firms developing or introducing new products, services an/ or methods to produce and deliver services that were not only new to the firm but also new to the market

The survey has one particular question focusing on whether the innovation was new to the market. The table above shows that of the innovative aquaculture firms, 35% report to have developed or introduced innovations new to the market. This share is lower than for the average of the manufacturing industry (40,7%) and substantially lower than for the service industry (46,3%).

Further the innovation study asks the innovative firms who has the main responsibility for the product, process or service development in the period from 1999-2001. Firstly, we will present the result of firms that have product innovation thereafter we will present the results of firms that have process innovations. However, one must have in mind that there are few observations from the aquaculture industry in the sample.

Table 6. Responsibility for product or service development in innovating firms

	Share of Manufacturing	Share of Services	Share of aquaculture
Mainly own firm	68,9 %	63.0 %	26.5 %
Firm in collaboration with other firms or institutes	22.3 %	21.1 %	62.8 %
Mainly other firms/ institutes	8.9 %	15.9 %	10.6 %
Total	100,0%	100 %	100,0%

Source: Community Innovation Survey for Norway 2001

1999-2001 (N=828,476,13)

The responsibility of the development of product innovations in aquaculture firms can mainly be ascribed to collaborative efforts with other firms or institutes (62,8%), suggesting a mix and match of internal and external competence used in development projects. Few of the aquaculture firms in the population report that the innovation effort is mainly carried out within the boundaries of the firm (26,5%). However, only 10,6% of the firms in aquaculture report that they can ascribe innovation responsibility to external partners only. Aquaculture firms in the sample seems to be more dependent on external interaction than the average manufacturing and service firms. In general manufacturing and service firms give internal resources the main responsibility for product and service development.

[25] NACE 15-37.
[26] NACE 50-74.

Table 7. Responsibility for process development in innovating firms

	Share of Manufacturing	Share of Services	Share of aquaculture
Mainly own firm	57.8 %	52.7 %	38.8 %
Firm in collaboration with other firms or institutes	27.3 %	31.7 %	36.5 %
Mainly other firms/ institutes	14.9 %	15.6 %	24.7 %
Total N=	100 %	100 %	100 %

Source: Community Innovation Survey for Norway 2001
1999-2001 (N=693,346,16)

Among aquaculture firms with process innovations, the largest share of firms report that the responsibility of the process development was the firm itself (38,8%), and the firm in collaboration with other firms or institutes (36,5%). Close to ¼ of the firms report that the external partner had the full responsibility of the development effort. This share is much higher than for manufacturing and service firms, suggesting that comparatively many aquaculture firms outsource process innovation to external actors. The table shows that the aquaculture firms differ from manufacturing and service firms in that few firms perceive internal resources being responsible for process innovations.

The innovation survey further asked the firms to report on costs related to innovation activity. This would give an idea of important sources of innovation used in aquaculture firms. The table below report on the share of firms that have engaged in different innovation activities, followed by a table that shows the share of innovation costs used on different activities.

Table 8. Types of innovation activities in innovative firms, share of firms reporting such activities

	Manufacturing (%)	Services (%)	Aquaculture firms (%)
N	1024	589	17
Total	2026	1656	43
R&D in own firm (internal R&D)	60.6	49.6	87.2
Acquisition of R&D services (external R&D)	33.5	23.5	58.5
Acquisition of machinery and equipment (incl. IT hardware)	35.7	36.0	22.9
Other external knowledge	18.0	26.9	16.0
Competence building	40.5	42.2	21.9
Market introduction of innovations	23.1	29.8	2.3
Design, other preparatory work for production and delivery	22.5	18.8	6.8

Source: Community Innovation Survey for Norway 2001
Other external knowledge: (purchase of rights to use patents, non-patented inventions, licences, know-how, drawings, and consultancy services (ex R&D), as well as computer programs not specified elsewhere). Competence building: (training of personnel in direct connection to development and/or introduction of new or improved products or processes)

A substantial share of innovative aquaculture firms report to have carried out some R&D activity internally (87,2%). The number of firms is much higher than for the average of manufacturing and service industry firms in the survey (60,6% and 49,6%). Acquisition of external R&D services is also reported by a relatively high share of aquaculture firms compared to manufacturing and service firms (58,5% vs. 33,5% and 23,5%). These results indicate that aquaculture firms have a high share of firms that do engage in both internal and external R&D activity compared to other industries.

The third largest share of aquaculture firms engage in "acquisition of machinery and equipment" suggesting that firms carry out developmental efforts in adjusting new machines and techniques to their own use. Few of the aquaculture firms engage in market introduction of innovation or design, or preparatory work for production and delivery.

Table 9. Types of innovation activities in innovative firms, share of total innovation cost by activities

	Manufacturing (%)	Services (%)	Aquaculture firms (%)
R&D in own firm (internal R&D)	61,2	50,7	79,9
Acquisition of R&D services (external R&D)	12,7	14,9	8,0
Acquisition of machinery and equipment (incl. IT hardware)	15,0	13,7	10,8
Other external knowledge	3,2	7,9	0,3
Competence building	2,1	4,4	0,7
Market introduction of innovations	2,8	3,9	0,0
Design, other preparatory work for production and delivery	3,0	4,6	0,3
Total	100	100	100

Source: Community Innovation Survey for Norway 2001

Other external knowledge: (purchase of rights to use patents, non-patented inventions, licences, know-how, drawings, and consultancy services (ex R&D), as well as computer programs not specified elsewhere). **Competence building**: (training of personnel in direct connection to development and/or introduction of new or improved products or processes)

Looking closer at the amount spent on different innovation activities, the share of costs used on internal R&D is the highest, especially for aquaculture firms (79,9% vs. 61,2 and 50,7%). However, aquaculture firms use few innovation resources on *external* acquisitions of R&D services (8%) compared to the average for the manufacturing and service industry (12,7% and 14,9%) . The second most important innovation activity for aquaculture firms is acquisitions of machinery and equipment. The aquaculture firms differ from the average of manufacturing and service firms in the low share of innovation costs used on activities like market introduction, acquisition of other external knowledge, design or internal competence building. In other words, aquaculture firms seem to put little money into innovation inputs being characterised as "*soft* innovation inputs"; knowledge intensive service activities besides R&D are not prioritised.

Sources of information

The innovation survey asked firms to evaluate sources of information or ideas for innovation activity. Through this question we are able to see what kinds of internal or external sources of information that firms perceive to give impetus to innovative ideas. The most important sources of information or ideas for innovation of manufacturing firms, service firms, and aquaculture firms are considered below.

Table 10. Sources of information or ideas for innovation activity of firms in aquaculture

	Manufacturing (%)	Services (%)	Aquaculture firms (%)
N	1021	588	17
Total	2002	1655	43
Within the firm	78.8	79.9	90.8
Other firms within the same industrial group	24.9	36.1	35.8
Suppliers of equipment, material, components or data programs	54.6	54.7	84.0
Customers	61.6	70.8	62.1
Competitors	35.7	34.7	31.1
Consultancy firms	21.8	26.7	43.7
Commercial laboratories/R&D enterprises	12.9	7.4	33.3
Universities and colleges	14.0	10.3	66.6
Public or private non-profit research institutes	17.2	13.6	57.4
Conferences, meetings, professional periodicals or journals	45.8	42.6	53.8
Fairs and exhibitions	44.0	37.5	59.7

Source: Community Innovation Survey for Norway 2001

Information sources evaluated as "medium to high importance"

The table above shows the number of innovative firms that perceive the information sources to be of medium or high importance. All firms do find that internal sources within the firm are the most important sources of information for innovation, especially aquaculture firms (90,8% vs. 78,8% and 79,9%). Among aquaculture firms vertical linkages with suppliers and customers are seen as important sources of information for innovation activity, suggesting that the information gained in the aquaculture cluster is especially important as innovation input. The emphasis on suppliers as an important source of information for innovation is

more dominant among aquaculture firms than for manufacturing and services in general (84% vs. 54,6% and 54,7% respectively). Suppliers have a crucial role in the innovation systems of aquaculture. Several firms are specialised to the various stages of the value creation process, and a number of service providers and equipment and materials suppliers have competence on their specific niche areas.

Aquaculture firms also value higher consultancy firms than other sectors. Aquaculture firms do also emphasise the knowledge infrastructure as valuable sources of information in innovation processes, more than the other sectors in the table. The table above suggests that aquaculture firms do emphasise both internal and external knowledge suppliers to be of importance to innovation in the firms, and it seems that aquaculture firms in the sample emphasise many different external knowledge suppliers. Aquaculture firms are more prone to make use of both the production system and the innovation system as a source for information for innovation activity than is the case among the average of both manufacturing and service industry firms, suggesting that the innovating aquaculture firms in the sample are tightly integrated into the national innovation system.

Innovation collaboration

External partners are important in firms' innovation efforts, and the innovation study asked the innovating firms what kinds of innovation partners they had in Norway. The table below report the findings.

Table 11. Share of firms reporting innovation collaboration by type of collaboration partners in Norway

	Manufacturing firms (%)	Service firms (%)	Aquaculture firms (%)
N	451	251	9
Total	727	620	22
Other firms within the same industrial group	29.8	22.9	22.3
Competitors	15.0	12.1	4.5
Customers	40.7	48.5	73.2
Consultancy firms	40.0	31.7	22.3
Suppliers of equipment, material, components or data programs	45.8	45.4	69.0
Universities and colleges	29.1	15.9	91.0
Public or private non-profit research institutes	38.4	20.0	64.5
Commercial laboratories / R&D enterprises	25.3	8.5	31.0

Source: Community Innovation Survey for Norway 2001
1999-2001; share of N=those who have answered the question

A large share of aquaculture firms has formal innovation collaboration projects with the knowledge infrastructure (both universities and research institutes). This number is much higher than reported by manufacturing and service firms. Aquaculture firms also differ in that a larger share of firms has collaboration projects with customers and suppliers, suggesting that vertical linkages are part of formal collaborative efforts as well. Aquaculture firms use consultants as partners in formal innovation projects to a lower degree than the other group of firms, suggesting that consultants are not explicitly used in innovation projects. The innovative aquaculture firms represented in the sample seem to go directly to the knowledge resources at universities and research institutes rather then to the "knowledge translators" in the consultancy firms.

Innovation barriers

Many factors may influence the ability of firms to innovate and be of vital importance to whether firms innovate or not. Hindrances to innovation may be of internal and external origin, and may be dealt with in various ways.

Barriers to innovation are perceived different by innovating firms in manufacturing, services, and aquaculture. The possible effects of these hindrances may be that innovation projects are seriously delayed, that the projects are interrupted for various reasons, and more damaging that the innovation projects are inhibited from starting up all together.

Table 12. Hindrances of innovation activities of innovating firms, 1999-2001

	Manufacturing (%)	Services (%)	Aquaculture (%)
Innovation project seriously delayed	16.3	16.8	0
Innovation project interrupted	18.9	13.9	26.4
Innovation project inhibited from starting up	18.7	15.7	15.5

Source: Community Innovation Survey for Norway 2001

The hindrances to innovation activity reported by the largest share of aquaculture firms in the sample are linked to the interruption of the innovation project. This can be linked to the lack of predictability of external factors that the fish farmers need to relate to, such as fish health and diseases, market price etc. The number of firms reporting this hindrance is higher for aquaculture firms than for manufacturing and service firms. Of the aquaculture firms 15.5% report to have innovation projects that have been prevented from starting up all together. This share is much in line with what is found for the other sectors.

In the 2001 survey the firms are asked to consider the importance of various types of barriers to innovation. The table below summarises how firms rate different factors possibly inhibiting innovation activities in the firms.

Table 13. Factors inhibiting innovation activities, medium to high degree of importance 1999-2001, all firms

	Manufacturing firms (%)	Service firms (%)	Aquaculture (%)
Too great economic risk	27.9	28.8	22.1
Too high innovation costs	28.2	27.2	26.7
Lack of appropriate financing possibilities	19.6	20.0	25.5
Organisational conditions	14.7	18.5	17.6
Lack of qualified personnel	16.1	15.1	19.9
Lack of technological information	11.8	8.8	16.5
Lack of market information	13.1	11.8	16.5
Too strict standards and regulations	12.2	9.2	12.0
Lack of interest for new products and processes amongst customers	19.2	19.8	8.6

Source: Community Innovation Survey for Norway 2001

All the firms in the survey have reported factors they perceive to inhibit innovation activities in the firm. The three most important barriers for innovation were “too high innovation costs”, “lack of appropriate financing” and “too great economic risk”. There is a larger share of aquaculture firms that report on “lack of qualified personnel” and “lack of technological and market information”, than is the case among the manufacturing and service industries as a whole, suggesting areas for policy intervention.

Financing innovation

Aquaculture firms in the innovation study emphasised that high innovation costs and lack of appropriate financing were hampering factors in relation to innovation. Jakobsen and Aarset (2002) carried out a study of fish farmers in Western Norway and asked the firms what kinds of external financing that were used in innovation projects. In general, the most important external public source of financing innovation in Norway is through Innovation Norway (former SND) and the RCN (Research Council of Norway).

Table 14. Firms' use of external financial sources in innovation projects the last three years, 2002

	RCN	SND Innovation Norway	Community	Other public	Private investors	Banks	Non	N
Farming of salmon and trout	14%	26%	6%	2%	24%	65%	18%	51
Farming of new species	18%	59%	18%	18%	59%	59%	5%	22

Source: Adopted from Jakobsen and Aarset (2002).
Share of firms with innovation activity that indicates use of external financial provider. (N=73).

From the table above it is obvious that fish farmers in Vestlandet have Innovation Norway as the most important public financer of innovation projects. This is particularly evident when looking at possible public financial sources. In the private market banks are the most important financial source. Private investors are used by 24% of aquaculture firms focusing on salmon and trout.

Summing up

Through the Norwegian part of the Community Innovation Survey we have found that more than one in three aquaculture firms in the sample had innovation activity in the period from 1999-2001. This share is larger than the average for all industries in the survey. As noted earlier one must have in mind that relatively few aquaculture firms are part of the survey, so one must be careful about making any generalisation for the industry as a whole. Even though many firms take part in innovation activity, few aquaculture firms report on products that are new to the market, suggesting that innovations are adjustments of existing innovations and only new to the firm.

Internal research and developmental efforts are important innovation activities for aquaculture firms. A large number of innovating firms do take part in this activity and a large share of total innovation costs are spent on such R&D activity . Only a small share of innovation costs are spent on external R&D. The second most important innovation cost is acquisition of machinery and equipment. 23% of aquaculture firms have engaged in this type of innovation activity. Around 1/5 of the aquaculture firms have taken part in competence building internally, however, only 0,7% of the innovation costs can be ascribed to that activity.

The most important external source of information for innovation is firms that are part of aquaculture firms' vertical linkages, and the general knowledge infrastructure. Consultancy firms is also valued highly by a relatively high share of innovative aquaculture firms (43,7%). Aquaculture firms in the population differ from the average manufacturing and service firms in that a large share of the firms value many different external partners as innovation input. Formal collaboration in innovation projects are carried out mainly with universities and colleges, many of which are probably initiated by public programmes. Aquaculture firms also take part in formal innovation projects with their suppliers and customers.

The innovative aquaculture firms in the CIS sample are R&D intensive actors that carry out formal innovation collaboration with the knowledge infrastructure in Norway to a larger degree than the average innovative firm. They also carry out formal innovation collaboration projects with actors along the whole value chain to a larger degree than is the case among the average innovative firms.

A large number of aquaculture firms emphasise innovation costs and lack of appropriate financing possibilities as factors inhibiting innovation. A relatively large share of firms also emphasise lack of qualified personnel. Of public actors relevant to the financing of innovation projects, Innovation Norway stands out as most important to the aquaculture firms.

Different innovation strategies[27]

The previous section gave an indication of how innovation takes place in aquaculture firms in Norway. By using the CIS we got an impression of how the "average" Norwegian aquaculture firm innovate. However, from qualitative studies we know that aquaculture firms differ in many respects, also with regard to the amount and type of innovation activity. These differences will have an impact on how firms relate to the system of KISA providers around them, and thereof how KISA are to have a role in innovation activities in the firm.

In order to better understand the factors that influence firms' innovation strategies and efforts, and to understand the underlying factors influencing firms' innovation strategies, we found it fruitful to present a qualitative study exploring aquaculture firms' innovation strategies.

The qualitative study focuses on how new knowledge is created, used, and spread in the innovation system of aquaculture firms (Aslesen et al., 2002). The analysis is based on 25 in-depth interviews with actors in the aquaculture industry. The study found the systemic perspective of particular relevance, and can be used to understand how internal and external knowledge intensive service activities are mixed and matched in aquaculture firms' innovation efforts.

In studies of innovation systems the point of departure may be to investigate how learning is achieved through interaction with others – so-called interactive learning. As such the knowledge base of the firm is thus one of the most important background variables to understand innovation strategies. By understanding the structure of the knowledge base, we may also gain insight into which type of interactive learning processes that may be observed empirically, for instance through a mapping of innovations made, and, not least, whether there are recognizable patterns in the sense that there are specific types of innovations that actually do not happen.

The study mentioned distinguished between two different strategic approaches to innovation activities among aquaculture firms:

1) A large number of firms base their activities, and the development and gradual improvement of these activities, almost exclusively on practical knowledge. Learning happens by experimenting, and the knowledge base underlying innovation activities is to a large degree tacit. Knowledge is gained through experience generated by effective operations and through practical solutions based on accessible practical and tacit knowledge in the field of aquaculture. We here denote such a knowledge base as *practical knowledge base.*

2) Another significant set of firms base their innovation efforts on interacting with and contributing to a system of scientific knowledge. The learning in these firms is based

[27] The text is based on Aslesen et al. (2002) and Orstavik and Aslesen (2004).

on interactive development, and the use of new scientific or technological knowledge. We denote such knowledge bases as *scientific*.

Further the study found that there are a surprising number of firms that have organisations marked by ad-hoc solutions to structural problems. A number of other firms, usually older firms, have a more structured management structure and more elaborated, functionally differentiated organisations. This line of argument provides the following table, as a classification of aquaculture firms (and their different innovation systems):

Table 15. Stylized variants of aquaculture firms

Knowledge base / Organisation	Practical	Technological/scientific
Entrepreneurial, ad-hoc	1)"The small family firm"	3) "Research driven entrepreneurs"
Structured management system	2)"The coastal enterprise"	4) "Science based process industry"

Source: Aslesen et al. (2002)

The model outlined above offers a suitable framework for the presentation of the Norwegian aquaculture industry and how different firms operate with respect to innovation:

1) "The family firm"

"The family firm" is usually a small aquaculture company. It is run by the owners themselves, often a single family, and with second-generation family members involved in the running of the company. The different functions within the firm often overlap. The family model firms tend to run their fish farms in an efficient and profitable way.

The administrative apparatus of such firms is obviously very small. The family firm is rarely in control over more than its own little piece of the whole value chain, and fish is sold in the spot market. Management focus is on costs, and its financial steering is conservative, because of the unpredictability (in relation to biology, market and regulations) characterizing production. The "written word" is of little value. Management philosophy is often that "*money not made today will never be made*".

Some of the firms in this group have made acquisitions in recent years, and have taken over responsibility for production carried out in more than one location. Thus, knowledge is extended in these cases through contact with other fish farms. Other important sources of information and knowledge are suppliers of equipment, feeds**,** medicines, and breeding. Professional magazines, fairs and exhibitions, and meetings also have some bearing on the acquisition of information, and may provide an important basis for an innovation process.

Innovations within the "family firm" tend to come about by employing existing knowledge in new ways. An important source of information and a collaborator in innovation projects are the suppliers of technological equipment. Incremental innovations based on practical experience and input from suppliers are rapidly dispersed and implemented by other actors in the industry – and firms seem to be quick to take advantage of their neighbour's innovations, as soon as these have proved successful. Such dissemination of knowledge is beneficial to the industry as a whole, but copying obviously diminishes the advantages of being the first mover in terms of competitiveness. First movers take the risks and the additional costs, the followers are "free-riders" in the innovation journey.

2) "The coastal enterprise"

"The coastal enterprise" has moved away from the entrepreneurial growth phase to a more mature, permanent operational phase. The firm has developed a more professional and

functionally differentiated organisation, with permanent management. A key motivation seems to have been to become able to exploit advantages of integrating different parts of the value chain - harvesting added value from more than one step in the value chain, and preventing opportunism in business partnership through vertical integration. ("The others are deceiving me!") The "costal enterprise" is not a large firm, not even in the Norwegian context. It has a small and effective administration, and is able to compete with the "family enterprise" on the basis of effective and profitable operations.

As far as communication with the suppliers of feeds, vaccines and equipments is concerned, these relations are mainly the responsibility of the administrative level of the costal enterprise. The suppliers provide the most important knowledge network of aquaculture firms that mainly base their activity on practical experience-based knowledge. The recruitment of feeds consultants may provide valuable contributions to the internal knowledge resources, and is said to be an important source of knowledge. In the interviews we have undertaken it is usually argued that there is a high degree of mobility of personnel within the aquaculture production system, which contributes to the dissemination of knowledge. Graduates entering the administration or middle management of a firm also provide important contributions to the knowledge base of the firm.

Several of the "costal enterprises" pursue a rather striking, "anti-innovation" strategy. We are told explicitly that they do not, and do not plan to, carry out any research and development, and they systematically avoid being in front with regard to new technologies and solutions. Most innovation, thus, take place in the same manner as is the case among the even more practically oriented and ad-hoc based activities of the family firms, basically through copying and through trial and error. The "anti-intellectual" characteristic of this culture seems to have been reinforced by the mounting pressures towards increased efficiency and adjustment to lower prices.

The implication of this is that the "anti-intellectual" and "anti-innovative" elements in the organisations gain strength. The emphasis on the effective running of the company through cost cuts undermines attempts towards innovation.

3) "Research based entrepreneurs"

The research based entrepreneurial firm is characterised by being in an early establishment phase. In contrast to the "family firm", these firms pursue a strategy that is not just based on immediate financial returns, but also include strategic initiatives that may pay off in the long-term. The focus of this aquaculture firm has thus moved away from operational aspects to scientific and technological knowledge development. The firm's business concept is unambiguously to cross the borders into knowledge generation, coupling diverse forms of knowledge, and including knowledge development on the frontiers of scientific research. Despite the highly technological orientation the firm pursues an open strategy vis-à-vis technological developments (based on shared and generally accessible knowledge), and pursue joint projects with people in research institutes and universities.

The research-based firm is often dependent on access to scientific knowledge that is open and accessible. "Research based entrepreneurs" are often tightly connected to the publicly financed "knowledge infrastructure" in Norway, and the close relationships to other research activities have a significant bearing on innovations. "Research based entrepreneurs" pursue innovations of a more radical nature (products or processes that are new or have been significantly improved, and/or also novelties in the market) since "new" knowledge is the

driving force of the firms' investments/business activities. The actors exert control over core knowledge in parts of the value chain over which they have control.

4) "Science based process industry"
Discriminate demand has become an important source of pressure on innovation in aquaculture in recent years. Demands concerning food safety and traceability are growing stronger, and are together with regulatory changes directing innovation activity in specific directions. Market understanding and market integration is one factor that distinguishes the "costal enterprise" from the "family enterprise". The former to a larger degree sell fish through long-term contracts, and is more oriented towards comprehending and coping with end user demands. Long-term contracts provide assurance with regards to sale, and enable a larger degree of continuity and dialogue with the market. One important challenge for aquaculture firms is the establishment of high-quality and stable channels of access to the market, in order to be able to understand, "translate", and use market signals in innovative behaviour in the firm.

This has been a reason for the establishment of large corporate structures in Norwegian aquaculture. Holding companies today operate and control a large share of total production, and, in times of scarcity of supply, will have the potential to exert significant market power. The primary objective of setting up such large corporate structures has obviously been to be able to gain additional profits on the basis of such power.

The fourth business type exploits the potential of integrating heterogeneous knowledge, covering the whole value chain, and encompassing both scientific and practical knowledge, in its efforts to innovate and to develop its business. This type of enterprises may build their activity on the control of unique scientific knowledge, and make use of this control to expand activities. Such control may come in the form of secrecy or patents, i.e. privatisation of the control over knowledge. These types of firms have the resources available to privatise and control both knowledge generation and its practical application (as opposed to "Research based entrepreneurs"). The company may not be as dependent on the collective knowledge base of the Norwegian aquaculture industry as the other aquaculture types, and may to a lesser extent participate in the informal networks that, for many actors, seem to be the most important channel for knowledge.

There are signs, however, that also the large "science-savvy" firms that we call science based process firms, may be of the opinion that a functioning public knowledge infrastructure with open access to scientific results is a significant advantage also to them. Such aquaculture firms have actually established relations with the knowledge infrastructure, both through mobility of personnel and through project cooperation. The fact is that also this part of the aquaculture industry has extended its network to include parts of the knowledge infrastructure, and in this way have made communication and networking between the heterogeneous actors easier. This development may, however, still only be in its infancy.

Summing up

By differentiating aquaculture according to knowledge base and degree of structured and functionally differentiated organisations, we found that aquaculture firms have very different approaches to innovation; from anti-innovation strategies to strategies of being in the fore-front of innovation in the industry. This differentiation between actors balance the picture of

aquaculture firms as being highly innovative, highly integrated in the production and innovation system of the industry, and R&D intensive.

The discussion above reveals that aquaculture firms relate differently to their environments. The degree to which firms are able to move beyond interactive learning in practical day-to-day operations depends on, among other things, the composition of their key knowledge base, their organisational structures, their size, and their maturity. That is to say, companies in the aquaculture industry in different ways relate to the possible sources of knowledge in their surroundings. We have seen how firms can be described as ideal types, and we have seen how different firm types vary systematically with respect to their approach to innovation.

By differentiating aquaculture firms into 4 stylised types, we have introduced an analytical grip that to a larger degree might enable us to study how the different types of firms make use of external sources in their innovation efforts. In the following chapters, we will therefore use this model as an analytical tool to better understand the role of KISA.

6. The role of KISA in innovation within the aquaculture industry

The overall question to be answered in this chapter is what role knowledge intensive services activities play in innovation in aquaculture firms. We will give answers to this question by looking at how the four main types of aquaculture firms presented in the previous chapter (in Table 15) build innovation capability through the use of knowledge intensive services, and what the most important sources for these services are. Through interviews with aquaculture firms, we have concentrated on how firms interact and cooperate with external providers of knowledge-intensive services, and the extent to which this interaction affects the ability to induce innovation in terms of introduction and sales of new and altered products, its modes of production, and the structure of supply of products.

We will discuss the findings from the explorative study of aquaculture firms' use of KISA in *innovation* in light of three main questions:

1. Why firms use different KISA, explaining what kinds of KISA are used
2. When firms use different KISA
3. How firms interact (co-production) with KISA

We will answer these questions by using aquaculture firms' innovation strategies as background variables (as introduced in the previous chapter). This provides us with the following table as a classification of aquaculture firms that will act as a categorisation of the questions why, when and how firms interact with KISA for innovation purposes.

Table 16. Innovation strategies of aquaculture firms. Why, when and how KISA are used for innovation

Knowledge base / Organisation	Practical/learning by doing Incremental, reactive innovation strategy	Scientific knowledge base radical and proactive innovation strategy
Entrepreneurial, ad-hoc	Type 1: Why/What, When and How are KISA used for innovation	Type 3: Why/What, When and How are KISA used for innovation
Structured management system	Type 2: Why/What, When and How are KISA used for innovation	Type 4: Why/What, When and How are KISA used for innovation

Source: Adopted from Aslesen et al. 2002

In the following we will describe how we understand the questions why, when and how in relation to KISA and innovation.

Ad 1) WHY: We will look closer at the different types of aquaculture firms in relation to work organisation, and as such give answer to *why or why not* knowledge intensive activities are used in firms' learning and innovation processes. Is it so that all firm types use KISA in these processes, if they do, WHAT types of KISA do they emphasise? Through a general mapping of work organisation, the most relevant knowledge intensive service for innovation, as emphasised by the interviewees, will be presented. We have adopted and adjusted a list of knowledge intensive service activities that was presented for the interviewed firms:

Possible KISA

- Research KISA
- Development KISA
- ICT development KISA
- Legal KISA
- Banking and financial KISA
- Accounting and auditing KISA
- KISA related to organizational development and strategy
- KISA related to marketing and sales
- KISA related to management and training

Below we have summed up what different types of KISA may offset innovation activities in aquaculture firms. The examples were given through interviews with aquaculture firms.

Table 17. Use of different KISA and examples of roles played in innovation in aquaculture firms

Different KISA	*Examples of role in innovation in aquaculture*
Research KISA	Contribute to radically/new products and processes related to core activities Gives the possibility for developing new technologies and other competencies that can give competitive advantages through long-term strategic focus on innovation
Development KISA	Contribute to incremental improvements, and new products and processes related to core activities leading to greater efficiency and optimalisation of operational activities
ICT development KISA	Reorganisation and improvement of administrative routines, administrative handling procedures Reorganization and improvement of the production side of fish farming and therefore have an important role in relation to operational processes within the firms
Legal KISA (i.e. linked to patent entitlements)	Are important in relation to secure innovation efforts in aquaculture, since there is a culture dominated by "copycats"
Financial KISA	These kinds of services can be decisive in relation to whether a firm can commercialise new product or process ideas, enter new markets, or make new acquisitions Do often have an advisory role of importance to the profile and direction of future core areas
Accounting and auditing KISA	Of little relevance to innovation. However the only external KISA provider for many small firms. Some engage in consulting and act as a bridge builder towards other external KISA
KISA related to organisational development and strategy	Can act as a driver for organizational change, and has been of utmost importance to large global actors the last years. Commented as "the most important innovation knowledge". Importance in relation to develop a strategic connection to innovation, organization of innovative processes, the direction and type of innovation
KISA related to marketing and sales	Innovations related to expansion of distribution and sales systems, branding and development of marketing skills, the developing of new markets which again can give relevant input into new product and processes
KISA related to management and training	Internal competence development gives input into internal KISAs understanding of own competence and its relevance to strengthening the firms' innovation capability

Further, we were interested in what the different types of firms perceived to be the most important provider of such knowledge intensive services. We have chosen the following providers:

Possible KISA providers

- Internal KISA: Service providers inside the organisation often organized as separate departments or units or sometimes only single persons providing services to the companies' different business units.
- KISA from the enterprise level.
- Knowledge Intensive Business Services (KIBS) defined as private sector firms providing knowledge based services to other business and non-business organisations, and the knowledge they provide is strategic, technical, and professional advice mainly employing the skills of information gathering, processing, and in particular interpretation of information.
- Research and technology organisations (RTO's) are public or semi public organisations that are specialised providers that offer services as their core business.
- Network KISA are actors that are part of a company's vertical linkages, such as different kinds of suppliers and customers. In this definition, we have also included firms that are part of the network of similar actors, such as competitors. This network is loosely structured around the company.

Ad 2) WHEN: After we have presented the different knowledge intensive service activities that firms use and the most important providers, we want to know when in the firms' life cycle these different knowledge intensive service activities are used as part of the aquaculture firms' innovation effort. Following this, we will present the findings on when the firms have chosen either to internalise or externalise knowledge intensive service activities.

Ad 3) HOW: We will further look into the innovation project between the aquaculture firm and the KISA provider internal or external, and se how the mix and match of KISA are used in innovation projects, referring back to the most important KISA activities presented earlier. In this question will also focus on what kinds of public policy measures the firms have engaged in.

The why, when and how questions are answered for the 4 different types of aquaculture firms presented above. However, firstly one must have in mind that there is no clear-cut way of categorizing firms according to the 4 types introduced, many firms will possibly be found in the intersection between the categories.

WHY, WHEN and HOW KISA are used in relation to innovation

TYPE 1: "The family firm"

Why do firms use KISA?

The degree of internal KISA in "The family firm" is at the minimum. The different KISA functions often overlap, since these functions by and large obtain their knowledge from practical experiences. The implication of this is that the aquaculture technician, the management, and the operational personnel often one and the same person ("a jack of all trades"), who facilitates operational improvements and makes the administrative apparatus and internal KISA very small. The organisation is still in its infancy, therefore lacking organisational maturity and professionalisation. In interviews firms' emphasise that the practical and experienced based knowledge of the workers is the most important input into processes of change in the firms.

The correct question to ask Type 1 firms is rather: Why do they not use/use so little external KISA for their internal learning and innovation processes? The answer is that these firms engage in few innovation projects of a more profound nature. When these firms innovate it is through practical knowledge. Therefore these firms do not relate to many different external KISA suppliers, they seldom encompass the internal resources (absorptive capacity) nor the time or money to relate to a broad set of KISA actors. The firms' development

efforts are mainly based on internal competence and on external relations that are part of the firms' vertical or business network. It also seems that personal ties, trust, and proximity to external KISA are important for the use of KISA. These firms use KISA on an ad hoc basis in relation to "fire fighting" in production and "must-have" activities, as well as in relation to banking and auditing and seldom in direct relation to innovation.

Through interviews, we found that the most important KISA for innovation are the following for "The family firm" firms.

1. Development KISA and ICT development KISA
2. Banking and financial KISA
3. Accounting and auditing KISA

When do firms use KISA?
In the following, we will elaborate on these different KISA based on interviews with aquaculture firms.

Development KISA and ICT development KISA
Knowledge intensive service activities in family firms in mainly used for development purposes and "fire fighting" in relation to operational and core activities. These knowledge intensive service activities are mainly carried out by internal KISA, and are seen as core knowledge in the firms, leading to improvements or incremental innovations. The internal KISA, according to the fish farmers, taking place within the day-to-day working environment is the most important input into innovation processes of the firms.

However, problems do arise that the firms cannot solve by themselves. These actors will primarily draw on competence from the knowledge intensive service activities acquired through the vertical networks of suppliers of feed, equipment (also ICT), and medication, as well as their competitors (similar firms)(network KISA). The firm will take part in development projects with actors in their vertical network, and are provided valuable KISA of practical- and experience-based nature (as opposed to scientific) affecting the development activities of both the fish farmers and the suppliers. The network KISA related to adjustments and incremental development activities (especially technologically related) is a very important external KISA for innovation in family firms.

Another important innovation driver of relevance to the family firm is the open and accessible knowledge that exists in the Norwegian aquaculture cluster as a result of fish farmers meeting informally and sharing their knowledge on "best practices". This sharing of relevant, practical information was in earlier years the most important reason for the rapid technological development in the industry. The "family firm" is dependent on these free and accessible knowledge in relation to their innovation efforts. Due to the larger degree of professionalisation in the industry, the pool of open and accessible knowledge is diminishing, putting pressure on the family firm to engage in professional relations with external KISA providers.

Together with their suppliers, some aquacultures firms have joined user-oriented projects managed by the RCN and in that way the firms have received input from RTO's. In this way, thus, the supplier serves as an important bridge builder between the aquaculture firms and knowledge milieus.

Banking and financial KISA
Through firm interviews we found that financial KISA form part of the managers' many tasks, and the managers also relate to external financial KISA providers. Smaller fish farmers to a greater degree relate to local banks and the financial services generated by the transactions they require. Many of the smaller actors today find it hard to get financial support for new projects since some banks have, on principle grounds, decided to trim down their portfolio of fish related companies. This is in it self an impediment to innovation for the actors in this sector. Moreover, the banks are no longer anchored in the local community, as was previously the case, but form part of global groups structures often located in another country. As such, the local approach evaporates, so does the local and tacit knowledge of the financial KISA. The small fish farmers, who seldom relate to other KISA providers than the banks, feel the quality of the financial KISA provided is diminishing because of this.

Accounting and auditing KISA
Accounting and auditing is by most of the firms externalized, or take the form of a combination of internal and external service provision. This kind of KISA are seen to have little impact on firms' innovation activity per se. The rationale behind employing internal or external accountancy services varies between the firms. In an interview with a smaller aquaculture firm it was revealed that this firm has opted for internalising the accounting service in order to achieve a closeness enabling easier access to all information. Also in larger companies with different types of activities, although within the same group structure, the internalised accounting strategy is grounded in the fact that costs of employing external services are the same as employing someone internally in the firm.

Other aquaculture firms have externalised accounting since they feel it is of little relevance to core activities or innovation.

As far as auditing is concerned it is a service everybody is required to obtain from external actors. It is thus an external KISA activity that everybody must draw on, and in some companies this is in fact the only external professional KISA used.

Strategies for internalisation or externalisation
Some companies wanted, as far as possible, to internalise their KISA, growing out of a wish to gain greater control over the running of the enterprise itself. When an external KISA was employed, however, it was grounded in the companies' lack of relevant internal competence in some areas necessitating the use of external suppliers.

One small company expressed concern about the fact that they, on the whole, used one single external KISA supplier, and as such did not know if they obtained "the best" services. Another company argued that external KISA suppliers made the company somewhat vulnerable, since the nature of consultants is to "steal" knowledge for selling it to other customers, suggesting scepticism towards external KISA providers representative of many of the interviewed family firms.

How firms use KISA for innovation
The family aquaculture firms have a rather limited scope of KISA search, both geographically and in relation to the activities acquired. These firms are in search for trustworthy KISA providers which have knowledge of the branch, and from which they can expect good quality services. From the interviews it seems that many of these companies

have had bad experiences with the use of external consultants not familiar with the aquaculture industry.

However, external development KISA gained through the companies' network of similar firms and suppliers of feed and equipment are the main and most important KISA for interactive learning of direct relevance to family firm's innovation efforts. The innovation strategy of these firms tends to come about by employing existing knowledge in new ways, and the result is incremental innovations based on practical experience. The collaborative projects are initiated when a problem arises and decisions are taken swiftly, the knowledge used is mostly practical and experienced based. These firms seldom engage in long-term strategic development projects with KISA suppliers.

In general there was only a small degree of interactive learning processes between aquaculture firms and external KISA in the field of auditing and finance. The relationship was often ad-hoc and time limited. However, in some of the interviews it became obvious that the local auditing company over time had started to provide several more KISA, especially with relation to economic and organisational management advice. The local auditing firm also seemed to play the role as a bridge builder to other relevant KISA that the firm needed from time to time (e.g. as legal KISA). When the local auditing firm also acquired these roles, the interaction became closer, and was of relevance to how the firms planned its future business strategy.

Today a large number of aquaculture firms are owned by large groups of enterprises. The group level functions as professional KISA suppliers to their subsidiaries. They offer services in relation to IT-systems, judicial advice, accounts, financial services and organisational development. For the subsidiaries, this constitutes a type of external KISA imposed by the Group level, which, today, most probably have lead to increased use and internalisation of knowledge intensive services in the companies than previously was the case. These Groups also pursue a strategy to continuously increase demand for internal (group) KISA by the units within the group.

TYPE 2: "The coastal enterprise"

Why do firms use KISA for innovation?

This firm has moved to a more mature, permanent operational phase, with a more professional and functionally differentiated organisation, and with permanent management. The most important reason for the changes appear to be that the size of the organisation has made a more formal structure unavoidable. Many of these firms are large multinational firms with departments worldwide focusing on different aspects of KISA. The firm has a professional middle management, which to some extent also possesses to some extent practical experience. It is hard to single out KISA that are mainly held internal in these kinds of firms, because there are several different strategies and reasons to both internalise and externalise all different kinds of KISA.

Even though the coastal enterprise has more internal KISA than the family firm, it still has a small and effective administration and a lean organisation with minimal "slack", meaning that they do not assimilate all needed KISA internally. Pressures towards increased efficiency and adjustment to lower prices mean that internal KISA has been regarded as a luxury that may be spared.

One might say that these actors relate to all different kinds of external KISA suppliers besides those that represent more formalised RTO's. The reason for this is that these firms do not base their activity on formalised codified knowledge, but on more practical and experienced based knowledge. This business strategy therefore places limitations on where these firms search for KISA providers. However, KISA related to development activity, to organisational change and strategy, marketing, and sales are activities that are close to the core activity and are as such to some degree kept internally. The list below outlines the most important KISA for innovation:

1. Development KISA
2. ICT development KISA
3. Banking and financial KISA
4. KISA related to organizational development and strategy
5. KISA related to marketing and sales
6. KISA related to management and training

When do firms use KISA
These firms use KISA in relation to innovation in the following fields:

Development KISA
Development KISA in the coastal enterprise is the most important KISA in relation to innovation, and is carried out in much the same manner as with the family firms. Innovation efforts are often a result of internal or external pressure for change, innovation efforts are seldom proactive development efforts. The most important development KISA in relation to innovation stems from the operational side, and is often the result of interplay with the suppliers of equipment. Innovations take place by employing new equipment, new feeds, etc., and at times the risk associated with possible failure is shared with the suppliers. The capacities of the technology are pushed to the limits, and the interactive learning processes that they take part in happen by trial and error. As with the family firm, the network of suppliers and similar firms in the cluster are the most important external KISA for innovation for the coastal enterprise.

ICT development KISA
Most of the companies interviewed purchase ICT development services from external KISA providers like KIBS in the private market. Even though ICT development KISA are primarily bought from external providers, there are important interactive learning processes going on between the internal and external KISA related to ICT development.

Firstly, ICT is used as an administrative tool for the management of the firms. There are significant variations in the type of ICT administrative tools employed in the various types of aquaculture firms. It may seem like the tools chosen depend on the degree of professionalism and the general maturity of the company. Companies over a certain size to a greater degree require administrative procedures in the day-to-day running of the company, and as such internal as well as external ICT development KISA are important. External ICT firms constitutes an important knowledge provider for the company, and new software solutions may be central components in the reorganisation and improvement of administrative routines, administrative handling procedures, etc.

On the production side of fish farming there are other important reasons for ICT use linked both to the feeding and production of fish. In relation to these activities fish farmers are large-scale users of external ICT development KISA. The external ICT development KISA

are often a collaborative effort between software companies and suppliers of equipment. One respondent stated that these suppliers on a weekly basis come to upgrade software and to solve problems. The software delivered to the aquaculture firms is characterized as only partly developed when introduced into the aquaculture firms. The software has to be improved, and adjusted to each specific user. The aquaculture firms express needs and ideas on change, while the external ICT development KISA contribute the necessary competence to bring these ideas to life, suggesting that the mix and match of internal and external KISA are important factors in relation to innovation in this area. The software solution, in combination with technological equipment is therefore important in the reorganization and improvement of the production side of fish farming, and therefore have an important role to play in relation to operational processes within the coastal enterprise.

Banking and financial KISA
All firms must relate to the financial aspects of running their business, and most of the firms have internal KISA that focus on these activities as part of their management functions. However, from time to time firms need loans and guarantees, and must therefore relate to external financial KISA providers. These kinds of services can be decisive as to whether or not a firm can make new investments, commercialise new product or process ideas, enter new markets, enter into take-overs, or participate in mergers. Banks- and other financial institutions thus constitute an important framework for the innovative activities of the aquaculture firms.

KISA related to organizational development and strategy
Most of the interviewed firms use internal resources for the development of business strategies and organizational development, although with very different emphasis. In some firms managers have this as part of their jobs, while in other more professional enterprise groups departments are focusing on these activities. Some of the interviewed firms only relate to internal KISA on these matters, the reason being that they themselves know the industry better than any external providers do.

Other firms use professional KIBS in the areas for organisational and strategic matters for many different reasons. Some firms report that through the use of external KISA in these areas they were forced to think through internal processes in new ways, and by that they were given important new inputs.

KISA related to organizational and strategy development is by some of the larger actors interviewed characterized as *the most important innovation knowledge* over the last few years. The crises that have taken place in the industry owe a lot to the fact that it has been an infant sector lacking sufficient control over the production and market aspects of its activities. Therefore, KISA on organizational and strategy development has made important inputs into all-embracing organisational change in recent years. The focus on this type of KISA has come as a result of takeovers, making their marks on this sector in recent years, which have led to disorganised and complicated organisational structures.

The interviews reveal that companies are asking for more research activity from external R&D actors within the area of “soft innovations”, like organisational and strategy development.

The extent to which companies are at all concerned with concepts such as organisational development and strategy depends very much upon whether or not they have a long-term

strategy for their own business activities, or whether they primarily focus on the efficient day-to-day running of the company. Unfortunately most companies within aquaculture today display a relatively defensive attitude vis-à-vis strategy and organisational change, and many companies are of the opinion that they do not have time to think strategically.

KISA related to marketing and sales
KISA related to marketing and sales will here denote knowledge intensive service activities concerned with the expansion of distribution and sales systems, branding and development of marketing skills, the developing of new markets, etc. We have in this study focused on a global industry that exports most of its products. This implies that KISA related to these activities is a core activity in aquaculture firms, and therefore all firms have persons or departments relating to these KISA activities internally. However, firms additionally relate to either professional traders or exporters in connection with the sale of fish.

Some of the aquaculture firms sell their fish in bulks to the spot market, and their marketing efforts are often directed at traders, and not to the end consumers (here supermarkets chains). These companies thus need not build up market knowledge or undertake market analyses, as they often only offer one single product.

Other firms have had as an objective to reduce the distribution strategy in such a way as to move away from the spot market, and increasingly look towards long-term partnerships based on formal agreements. Some of these firms today exert control over the whole value-chain, from eggs to fish ready for consumption. Valuable KISA through customers' demands and wishes is often transmitted through the market link, and as such will be a messenger and source of innovative processes in the core activities of a company. Thus, possessing high-quality internal KISA within the areas of sales and marketing are therefore of great importance to innovation within the firms.

KISA related to marketing and sales have a particular focus today, in that the aquaculture firms have come to realise that the narrow focus on production and volume has failed. Many aquaculture firms nowadays have altered their organisations in such a way as to allow the market significant influence over production. In one of the companies interviewed a total reorganisation of the enterprise had taken place in the direction of making marketing and sales the main line of activity within the organisation. The focus was now "to whom shall we sell and how much", rather than "producing as much as possible" within the licences held.

KISA related to management and training
Many firms train employees by use of external expert service provided either by the enterprise group, by Higher Education Institutions (HEIs) or by KIBS. However, there were great differences as to what kinds of training services the different types of aquaculture firms actually engaged in.

The companies' activities in relation to education and training of employees seem to a large degree to be determined by the level of maturity, the degree of professionalisation, and internal KISA. Companies belonging to an enterprise group seem to be more conscious about directing attention at internal knowledge development in the company. Here we are talking mainly about the purchase of external KISA for the purpose of training and competence development. A strategy of continual training and competence development may be seen to be derived from a wish to retain employees. Retention of employees has

been a significant challenge in recent years, both because restructurings have lead to significant redundancies, but also because of recruitment difficulties caused by the large degree of negative publicity that the sector as a whole has endured in recent years.

The interviews revealed a number of reasons why companies engage in training of internal KISA personnel:

- To educate operation managers and other administrative personnel. In connection with this, companies have taken advantage of courses provided by among others BI (Norwegian School of Management). Due to the geographical distance between companies and cities/more densely populated areas providing such training, KISA providers are often able to offer on-site training within the companies themselves. Professional KIBS have also been used in such course activity. Those firms that are part of a Group do also hold training and management courses, especially then directed at top managers.
- On the production side there is a need for crafts certificate training. Some of the interviewed firms stated that it was possible to carry out such training in-house. In such cases the company will contact the county municipal education office (responsible for fisheries subject), and through this office training relevant to the desired subject areas is initiated.
- Within fish farming there are also a number of obligatory courses that employees must take. For example courses on the Act relating to worker protection and working environment (AML), first aid courses or the like depending on the activities of the company. Most of these courses are run on an ad-hoc basis, and are purchased externally.

What is the effect of internal training KISA on innovation in the company? Through the interviews we found that:

- Training schemes of different types give the employees a new set of "glasses" through which they could see their workplace. This can offset new ideas into the organization of different kinds.
- Trough training schemes employees meet in informal settings, making it easier to discuss work related problems in different ways, often with a focus that is not so constrained by everyday tasks.
- Training seems to provide more motivated and qualified employees that can be a facilitating factor in innovation

Strategies for internalisation or externalization
Some of the firms interviewed gave the impression that the management philosophy was one of making as little use as possible of external KISA. Management would rather use internal knowledge intensive resources to solve problems. Another important factor in this regard was a desire to maintain continuity in the internal learning processes within the company, and not be dependent on external KISA when problems arise.

Many of these firms are in a consolidation phase, so KISA linked to organisation and strategy development, financial services and management training is perceived to be a very important innovation input. However, to buy "soft innovation inputs" are quite new to this industry, so the demand for these services and the supply of relevant services is still in its infancy.

The reasons for employing external KISA may be a lack of necessary competence within the company itself, and that the purchase of KISA provides opportunities for knowledge transfers and learning and may contribute to an increase in the quality of work, and provide support in areas where the internal KISA has not been given priority. A lot of companies live by the philosophy that "money not made today, are lost tomorrow". Most of the companies have one primary focus and that is the efficient day-to-day running of the company. The implication of this is that one seldom has time to think strategically in

relation to one's own company. The companies are caught in the efficiency trap, which places restrictions on the type of external KISA they actually look for in the market.

Most of the coastal enterprise firms interviewed argued that the reasons for externalising services were increased need for control and predictability in relation to one's own operations. The companies experience harder competition within the industry. The fact that some of the actors in the industry increasingly are acquiring a more direct relationship with the market means that one has, to a greater degree than before, to seek assistance in relation to the setting up of contracts (each production is contract-based), and that one has to be sensitive to signals and demands from the market (traceability and the like). Stricter demands from financial institutions were also raised as a factor contributing to an increase in the use of external KISA. Few companies can afford to build up a "comprehensive and expensive administration", and will for that reason possess less internal capacity to handle increasing external demands. The nature of the competition within the industry makes it necessary to focus on core activities.

At management levels one may find examples of external KISA being used for the purpose of taking an "objective" approach to how the business is run. An external consultant is not constrained by internal conflicts or cultures that could be viewed as a barrier to internal change. Advice provided by external actors may also be used by management to foster support for large-scale processes of change, it may provide legitimacy beyond that of the internal KISA. On a more general level one may argue that central characteristics of the industry today is the use of contracts and an increasing degree of formalisation. Increasing use of IT based production systems to reduce production costs implies that the purchase of and interaction with this type of KISA suppliers will continue in the future.

In the industry there is little tradition for purchasing services related to "softer" values in the company. Thus, it is interesting to note that many companies believe that they will experience an increasing need for external KISA in these areas also in the future.

How firms use KISA for innovation

When asking the aquaculture firms in what way external KISA have a role to play in relation to their core activity, none of the respondents answer that such activities may be seen to be *a driving force* for innovation in the firm. Besides the interactive learning processes gained through development projects with suppliers, customers, and similar firms (network KISA), few of the respondents say that external KISA contribute to much learning that goes into the core activity of the firm. External providers rather supply KISA of relevance to *support* the firms' innovation efforts by giving direction on type of innovation to engage in through their knowledge from other countries or markets. KISA acquired through global KIBS can be used in benchmarking own activity in light of related industries.

One interviewee said that by buying KISA externally you were able to receive the most specialised and competitive knowledge in the field. It demands great investments to internalise the best KISA in all fields of relevance to innovation. This continued matching of internal and external competence within different areas provides the basis for an interactive learning process regarded as important to the company. Some of the coastal enterprises use external KISA actively as a learning strategy, and the firms have come to the realisation that it cannot be best in all areas of its activity. An important implication of this is that knowledge about who the best and most relevant KISA providers are, is an important knowledge.

Through the interviews it was obvious that these firms took part in projects focusing on the firms' innovation activity through financing by Innovation Norway and RCNs user oriented projects. One of the firms had a project that was partly financed by the county council.

The family firm had no strategy towards using external KISA provision as part of their learning and innovation efforts. However, they were given valuable innovation input "indirectly" through their "must-have" KISA suppliers, such as accounting, banking and ICT suppliers. The coastal enterprise, however, use external KISA suppliers explicitly for the purpose of learning and innovation, even though they also have a low focus on innovation in general. Since their organisation is more professionally organised into specialised departments, these firms to a greater degree demand professional business services than the Type 1 firm. Therefore, the coastal enterprise seems to be more integrated in the production and innovation system, and therefore potentially might have more knowledge intensive service input into their organisation than the family firm. However, since the coastal enterprise also base their innovation on practical and experienced based knowledge, parts of the knowledge infrastructure is still not integrated in their innovation efforts, possibly challenging the innovation potential for the coastal enterprise in the long run.

TYPE 3: "Research based entrepreneurs"

Why do firms use KISA for innovation?

Type 3 is a research based entrepreneurial firm. Most companies have internal KISA focusing on accounting and budgeting that may be linked up with external KISA providers such as auditors and tax authorities. However, almost all other KISA functions are out-sourced. These firms are often in the research front within their field, and most of the firms specialize in areas such as feed and fish health, and some of the firms may even be categorised as biotechnology firms. "New" knowledge is the driving force of the firms' investments/business activities. The firms internalise research KISA in parts of the value chain over which they have control. It is important for these firms to protect their knowledge and technology through IPR protection. None of these companies employ internal KISA solely in relation to IPR, but some do have employees that, as part of their job as researchers, relate to legal KISA. Some of these firms are part of an enterprise group, and receive valuable external KISA through these sources. However, some of these research based entrepreneurs stand alone, and many of the actors have too little focus on KISA linked to business development, such as strategies for commercialisation. The most important KISA for innovation are listed below:

1. Research KISA
2. Legal KISA
3. Banking and financial KISA (venture capitalists)

When firms use different kinds of KISA

Research and network KISA

The research based entrepreneur focus solely on their core activity, which is research linked to parts of the value chain in aquaculture. The focus is on scientific and technological knowledge development, and firms unambiguously cross the borders into knowledge generation. These firms use external research KISA (directly from research institutes, universities, laboratories etc.), since they do not encompass all the needed facilities or knowledge to carry out the projects internally. Research projects in aquaculture today is characterised by a rapid pace of change and a high degree of complexity. Innovation projects

are also very expensive to carry out, and the uncertainty surrounding the outcome of such projects therefore means a great economic risk. These are reasons to search for external collaborates and/or to acquire knowledge intensive service activities that are "open" and accessible, like public research KISA, or shared and generally accessible knowledge of the cluster (network KISA).

Compared to the family firms and the coastal enterprise, the research based entrepreneur differ in that they go directly to the knowledge infrastructure in their search for scientific knowledge. The scientific knowledge that goes into the family firm and the coastal enterprise are often "translated" and embodied into machinery, equipment or services provided by suppliers. The coastal enterprise differs in that they do not need "translators" in their search for new knowledge, they are able to go straight to the sources.

Legal KISA
One would perhaps assume that the research based entrepreneur would try to shield new solutions internally, and exert control over them in new and more effective operations. What is striking, however, is that so many of them explicitly prefer an open and accessible knowledge base for the whole cluster. In some cases, however, we can still observe an asymmetry here. Some very competent research based firms admit being dependent on open sources of knowledge, while at the same, for business reasons, are systematically protecting their own knowledge and technology through secrecy and more formal IPR protection. In that way legal KISA are important for these actors in that their competitive advantage may be made to last longer by use of IPR, and through knowledge of how to acquire legal KISA.

Banking and financial KISA (venture capitalists)
The existence of "research-led entrepreneurs" is very much dependant on the availability of risk capital put into companies with a potential for growth and profitability. Venture capital firms may contribute with capital and competence to companies, and few venture funds have had the marine sector as its main area of investment activity. Sector specific funds spawn investors that thoroughly understand the core nature and logic of the industry. Venture capital firms entering the sector have been important to the professionalisation of the enterprises in which they often become owners themselves, particularly in relation to management and operations, as well as providing contacts with networks of other financial actors, which again enables the company to approach the ordinary financial and capital markets.

Strategies for internalisation or externalization
Through the interviews we found that there were different reasons to engage external KISA providers in relation to R&D KISA. Important reasons given were lack of facilities needed to carry out in-house research. Time constraints internally are also mentioned as a reason for drawing on external KISA actors. Other benefits related to externalising R&D activities are the reductions in fixed costs related to internal research KISA, and if the governance of the project runs well, there will be reduction in governance costs. The different externalisation strategies related to R&D KISA may take the form of outsourcing, sub-contracting, joint-ventures, or strategic alliances.

How firms use KISA for innovation
The coastal enterprise needs to include external knowledge by RTOs, and therefore pursues interactive learning processes with external KISA that leads to innovations of a more radical

nature. The projects might lead to products or processes that are new or have been significantly improved, and/or also are novelties in the market.
The projects are often long lasting, and many are co-financed through user-oriented programmes of the Norwegian Research Council. Through interviews it was obvious that many research based entrepreneurs did relate to public or semi-public RTOs for the purpose of obtaining co-financing of projects.

TYPE 4: "Science based process industry"

Why do firms use KISA for innovation?

These companies are often a part of a large corporate structure with all of the different KISA activities to some degree internalised or found within the enterprise structure (or holding company). These firms integrate KISA from the *whole* value chain, in innovation processes, and have the resources available to privatise and control both formalised knowledge generation and its practical application. The objective of knowledge development in such a company is to develop a competitive advantage, which needs to be protected from competitors. There are very few such actors in Norway. The most important KISA for innovation are listed below:

1. Research and development KISA
2. Legal KISA
3. KISA related to finance, organizational development and strategy
4. KISA related to marketing and sales
5. KISA related to management and training

When firms use different kinds of KISA

The science based process industry are able to use all different kinds of KISA that can match internal KISA, also research KISA, however these firms are also restricted by the pressure towards reducing operating costs. These firms have reached a maturity, which has made them more conscious in relation to what KISA they should have internally, and which they should out-source. However, one informant said that the increased complexity, structural changes, and the general pace of change in society would force these firms to use external KISA to a larger degree than today. Among other things, the constant demand from public authorities, finance institutions, and the market are reasons to buy KISA. These firms also use professional KISA in periods of expansion and growth both nationally and internationally, both on an ad-hoc basis and in long term projects. They usually have a global search for the best actors to supply them with external KISA.

Research and development KISA:

Through interviews we found that in relation to research KISA critical factors in offsetting innovation is to hold a critical mass of competent research KISA internally, and a focused research activity. Internal emphasis on R&D KISA will also provide the companies with freedom vis-à-vis their own creativity, which may spur radical innovations.

The science based process industry exploit the potential of integrating KISA from the whole value chain, and encompass both research KISA and development KISA in its innovation efforts. These companies may not be as dependent on network KISA or the collective knowledge base of the cluster as the other aquaculture firms. This means that free and accessible knowledge through network KISA are of less importance, and these actors may therefore to a lesser extent participate in informal networks in the cluster.

R&D activities are very specialised, and are regarded as "state of the art" within their fields. These firms have an offensive, systematic, and long-term innovation strategy, which implies great risks with regard to outcome. These actors are not typical for the aquaculture industry in Norway.

However, research KISA within aquaculture firms are not developed solely by private firms. Publicly financed research activity has been of utmost importance to the development of the aquaculture industry in Norway. Therefore internal research KISA are often mixed with external research KISA (like research institutes) in research projects co-financed by public money. This kind of internal and external KISA have a high impact on the innovation activity of the aquaculture firms. Important external research KISA providers are institutes like Fiskeriforskning, Norwegian College of Fishery Science (Norges fiskerihøgskole), SINTEF Fisheries and Aquaculture (SINTEF Fiskeri og havbruk), Marintek, Institute of Marine Research (Havforskningsinstituttet), Akvaforsk. The private actors' incentives to use these RTOs are often grounded in the possibility of gaining access to public co-financing of innovation projects.

Legal KISA
The objective of knowledge development in such a company is to develop a competitive advantage, which needs to be protected from competitors. Firms with research activity will thus have incentives to hold on to their knowledge. In the following, we will focus especially on patent entitlements and on the role of this kind of KISA in relation to innovation.

Legal KISA will not have a role to play in generating new products or processes in the aquaculture industry, but may play an important role in maintaining the competitive advantage of being the "first mover" in relation to the development of a product or process. This function is served through obtaining copyright on products or processes, and thereby temporarily obstructing others from copying something into which significant developing funds have been put. The copycat logic that prevails in the aquaculture industry has been to be an impediment to innovation in the industry itself.

Through the interviews it was revealed that companies more and more often exploit the opportunity to have their products patented, in particular those companies with their own R&D units. Possessing employees dealing with issues related to patents seem to be an important internal KISA. None of the respondents possesses their own legal units, but they do have employees whose main responsibility is directed at this type of tasks. In one company a member of staff devoted 50 % of his time to patents. He was an important advisor for the other internal researchers, and he also worked with external legal KISA, both nationally and internationally. The most important part of the work was then to run processes in connection with patent applications. Another important aspect of the internal KISA was to be a "patent scanner", i.e. looking for patents posing a threat to the company. One possibility in this regard is then to oppose the patent application, and afterwards evaluating the extent to which the patent is weak or strong. If it proves to be a weak patent one does not take action, if it is a strong patent on the other hand, action is taken. At this stage it will be appropriate to bring in external KISA in the form of professional legal services and lawyers.

Another important responsibility of the internal KISA in connection with patents will be to monitor and follow up ones own patents. Many of the companies state that the issue of

copyrights and patents is becoming increasingly more complex, and as such the demand for this type of KISA will most probably increase in the future.

KISA related to finance, organizational development and strategy
The use of knowledge intensive services within these areas seems to be triggered by many different factors. Mergers and acquisitions, changes in ownership and challenges in relation to the market seem to generate a demand for external KISA in these firms. For the science based process industry it seem relevant to use KIBS that had experience at an international level to "benchmark" and give assessment of the international situation. These actors use professional KISA providers to give them financial help and advice within many different aspects of their activities. Some of the firms among the coastal enterprise firms and science based process industry firms have in recent years been listed on the stock exchange. In connection with such transitions the companies may need expert assistance. These services will usually be purchased in connection with time-limited projects directed at solving specific types of problems. These are KISA services the companies themselves find extremely costly. KISA linked to financial, organisational, and strategic aspects often overlap and are hard to differentiate, but are altogether regarded as important in relation to processes of organisational change that are taking place in the larger professional companies today

KISA related to marketing and sales
The emphasis on KISA with marketing and sales as driving principles is considered to be the locomotive of organisational innovations in many of the companies we have analysed. It is thus an example of how different knowledge intensive service activities have become intertwined, both organisationally, strategically, financially, as well as in relation to marketing and sales.

By making KISA related to marketing and sales the core activity of an organisation, it means that knowledge intensive service activities derived from interaction with the market becomes important innovation drivers of the firm. Market demands in relation to for example food safety are tasks the firms themselves must now relate to and know the answers to. One interviewee said that the integration into the market-side of the value chain, and the KISA the firms is confronted with in relation to this integration, has set of ripple effects in the whole organisation; from setting the agenda in the research department to how the production process is managed. However, one must bear in mind that this is relevant only to the larger enterprises, which have a diversified set of internal KISA able to respond to and use the inputs from external KISA in internal learning processes.

The interviews revealed that in the future increased focus will be placed on the marketing-side of things, and that the demand for both internal and external KISA in relation to these activities will increase.

KISA related to management and training
In the science based process firm, internal KISA are of utmost importance for the innovation processes that the firms take part in. Therefore there is a focus on training on internal KISA, much in line with what we found in Type 2 firms. However, the science based process firm have a broader set of internal KISA actors, and therefore engage in a more diversified set of internal training activities. These firms also use the enterprise level as external KISA providers, together with more professional suppliers as KIBS and Higher Education Institutions.

Strategies for internalisation or externalization
Through interviews with the science based process firm, we found different reasons for internalising or externalising research KISA. The reasons for internalising Research KISA in the science based process firm were that the company itself knows best its own research needs. Other advantages were that it provides more transparency in the research process, i.e. that one may talk openly to all participants in projects without being limited by principles of confidentiality. There may be some risk involved for a research unit to incorporate an external KISA provider, because the learning acquired by the KISA may benefit a competitor company. The risk is greater in situations where the aquaculture firm exerts relative control over an area, but is less significant in situations of uncertainty. Proximity and the opportunity to follow the research project closely, and as such keep up to date with the issues under consideration, were also raised as motives for internalisation.

Proximity to research projects and the results of these projects, means that the companies themselves, being in possession of the core competence, may to a greater extent be able to communicate with customers (marketing units, factories etc), as opposed to a situation in which an external KISA provider acts as an intermediate possessing the core competence. This is the case in relation to a range of smaller and medium sized aquaculture firms that do not possess their own R&D units. When customers raise questions regarding the food used, the company will have to refer the customer to the feeds supplier, since they do not possess the necessary competence themselves. The fact that R&D related KISA are carried out internally may make the commercialisation process more efficient, in that the company is an integrated structure and as such is able to take into consideration the whole value chain (in particular marketing and the needs of customers) in its research.

Other benefits linked to internalising R&D KISA are the degree of quality control and independence. The response time and the increased operational flexibility are also important reasons for internalising activities. Internal KISA may reduce total costs in real terms.

In interviews with the science based process firms, some emphasise that by buying KISA on the external market you are able to get hold of the most specialised and competitive knowledge on the market. Larger professional companies purchase KISA from those companies that possess the best competence regardless of location. It is important that KISA suppliers possess high quality professional competence, and most of them are of the opinion that generally speaking the professional quality of KIBS companies has improved in recent years.

The companies do not, according to themselves, become more vulnerable when buying external KISA. They offer different reasons why this is the case, but one important reason is that they do not purchase external KISA that has to do with the core activity of the company. One group states that they consists of a collection of individual companies pursuing quite different activities, and although they employ a consultant in one part of the company, the consultant will not acquire insight into the whole group as such.

How firms use KISA for innovation
The science based aquaculture firms have actually established relations with the knowledge infrastructure, both through mobility of KIS personnel as well as through long-term project cooperation. Interactive learning processes with external KISA of relevance to innovation are found. Many of these relations are long-term. The collaboration projects with network KISA are less important to innovation, but can be seen as important source of input for the

agenda of research activities carried out in these firms. KISA input from network actors can offset new research tasks internally. On the other side these firms also often engage in projects linked to the core knowledge of the supplied products, and are not dependent on the suppliers' ability to "translate" scientific knowledge into practical knowledge. The most important interactive learning processes, leading to competitive advantages for science based firms, are their relationships with RTO's. Unfortunately there are few aquaculture firms in Norway today that have developed relevant internal KISA to be able to make direct use of knowledge from RTO's, these firms are uncommon in Norwegian aquaculture today. Relations between aquaculture firms and RTO's are often initiated by user oriented R&D programmes through the Research Council of Norway.

Summing up KISA in relation to different innovation strategies

The aim of this chapter is to understand what role knowledge intensive service activities play with regard to innovation in the interviewed aquaculture firms. We found it reasonable to categorise the interviewed firms according to different innovation strategies, since firms' innovation strategies (as a function of internal knowledge base and organisation of activities) may explain what kinds of interactive learning processes firms engage in with external KISA providers. Innovation strategies are therefore used as a tool to understand why KISA are used, the types of KISA used either internally or externally by aquaculture firms, when KISA are used, and how. Since the aquaculture industry consist of many different types of firms, an aggregate analysis of the industry might fail to include important differences and developmental tracks *within* the aquaculture industry.

The main findings in this chapter is that even if firms are categorised in the same industry, their *use* of knowledge intensive service activities and their *role* in innovation differ according to firms' knowledge base and type of organisation. The dynamics of the interaction between KISA providers and aquaculture firms differs along these dimensions, and policy directed at improving innovation capabilities by means of KISA must relate to these important differences between firms.

The most common aquaculture firm in Norway is to be found in the intersection between the family firms and the coastal enterprise. For these firms internal KISA are often at a minimum, suggesting that the level of internal competence able to recognize the value of new information, assimilate it, and apply it to commercial ends, is limited. However, through the interviews we also found more professional enterprises among these types of firms (1,2) with a particular focus on competence building by active use of external KISA, raising the standard of internal knowledge intensive services. Having low levels of internal knowledge intensive services affects firms' abilities to absorb new information and knowledge from external actors, it also restricts the "set of significant others" that such firms can relate to, and therefore what kinds of knowledge intensive service activities that can go into innovation processes.

Through interviews, we found that firms had great expectations to that the KISA providers were in possession of thorough knowledge of the industry. These strict demands have possibly made it more difficult for external KISA providers working towards other branches or fields to be accepted as relevant KISA suppliers. One can say that there is a general scepticism towards the use of external KISA as a source of innovation, however, external providers is now being employed to a greater degree than was previously the case, especially in the fields of development activities (also moving towards more scientific knowledge milieus) linked to product and process innovations (often incremental), in relation to ICT

projects, in relation to banking and financial assistance, and in relation to accounting and auditing. The external actors used are primarily the enterprise level, the network of suppliers and similar firms, and "must-have" knowledge intensive services. Some of the coastal enterprise firms have also been engaged in user oriented R&D projects, where there has been knowledge input from scientific milieus as well. However, the most important source of knowledge intensive service activities, leading to innovation, is the free and accessible knowledge from the Norwegian aquaculture cluster.

These firms main challenge is to develop internal KISA so as to be able to manage the knowledge and the innovation process associated with the external supply of different KISA relevant to their specific innovation efforts.

The research based entrepreneur and the science based process industry firm engage in innovation projects of more radical art employing also scientific knowledge intensive services into the process. The science based entrepreneur firm relates to network KISA providers, to other parts of the enterprise group, and to RTOs. The most important KISA for innovation is research KISA, legal KISA, and banking and financial KISA. The science based process industry firm is the most professional aquaculture firm, using a much broader set of external competence providers in innovation than any other aquaculture firm. This type of firms, also engage in other industrial activities, have contributed to increased acceptance for the purchase of external KISA. The restructuring of the industry has also contributed to an increase in the demand of external knowledge intensive activities in relation to buying and selling of companies.

Both the research based entrepreneur and the science based process industry firm are better able to make use of externally available information than the family firm and the science based process industry, possibly a result of the level of competence and absorptive capacity of these firms, making them more able to translate significant knowledge into the innovation process.

In general it may be argued that the focus on "soft innovation" inputs is starting to gain ground in the aquaculture industry. When the firms themselves start to focus on the need for such knowledge intensive services, one can expect that the supply and quality of such services directed at the industry will increase.

When looking at the different types of firms, it seems obvious that there are certain prerequisites regarding the internal knowledge base and degree of professionalisation in management that must be in place, if successful learning process between KISA providers and aquaculture firms is to happen. This certainly challenges the view of KISA providers as *always being* an "innovation agent" (Metcalfe and Miles, 2000).

In the following we will firstly present a figure summing up our findings on why, when and how KISA are used in the 4 different models, based on the discussion in this chapter. In the interviews firms were also explicit about what kinds of innovation they experienced as a result of interactions with KISA providers. The first table shows that different actors use different sets of KISA providers, and therefore will not be in a position to attain all the potential innovation benefits. We also found through the interviews that firms had different strategies with regard to internalising or externalising KISA. We have summed up the findings in the second table, and made a division between KISA in general and research KISA.

Table 18. Why, when and how KISA are used in relation to innovation among interviewed aquaculture firms

Knowledge base / Organisation	Practical/learning by doing			Scientific knowledge base		
Ad hoc organisation	**Type 1: "The small family firm"**			**Type 3: "Research driven entrepreneurs"**		
	Most important KISA for innovation:	***KISA provider:***	***Types of innovation:***	***Most important KISA for innovation:***	***KISA provider:***	***Types of innovation:***
	Development KISA and ICT development KISA Banking and financial KISA Accounting and auditing KISA	KISA from enterprise level Network KISA "Must have" Local KIBS (auditing, finance)	Organisational and strategy innovations Incremental technological innovations Incremental change of business strategy	Research KISA Legal KISA Banking and financial KISA (venture capitalists)	Network KISA KISA from enterprise level RTO's	Product, process, market Radical science based innovation (in parts of the value chain)
Professional management	**Type 2: "The coastal enterprise"**			**Type 4: "Science based process industry"**		
	Most important KISA for innovation:	***KISA provider:***	***Types of innovation:***	***Most important KISA for innovation:***	***KISA provider:***	***Types of innovation:***
	Development KISA ICT development KISA Banking and financial KISA KISA related to organizational development and strategy KISA related to marketing and sales KISA related to management and training	Network KISA National/global KIBS (finance, strategy, training)	Incremental innovations in the whole value chain Organisational and strategy innovations	Research KISA Development KISA ICT development KISA Legal KISA Banking and financial KISA Accounting and auditing KISA KISA related to organizational development and strategy KISA related to marketing and sales KISA related to management and training	RTO's. Network KISA National/global KIBS (finance, strategy, training)	Radical science base innovation in the whole value chain Incremental and radical changes in all parts of the value chain Organisational and strategy innovations

Table 19. Reasons for internalising or externalising KISA in general and research KISA in particular

	Reason for internalising KISA	Reasons for externalising KISA
KISA in general Type1,2,3,4	• Protect areas were you have competitive advantage (core knowledge) • Larger degree of control over own activity in general gives independence • Secure continuity in internal learning processes and the opportunity to anchor new knowledge • Higher operating flexibility • Reduced response time to external actors • May reduce total cost in real terms	• Provides the opportunity to focus on core areas in times of fierce competition and increased specialized demands from markets and finance institutions • Provides access to the most professional and specialised knowledge in the field • In need of specialized knowledge • Cannot afford to build up relevant KISA internally • To be used in time limited projects • Provides greater legitimacy than internal KISA decisions
Research KISA Type 3, 4	• Freedom to focus on own research activity according to own needs • Sets off creative processes internally which can affect the whole organisation • Knowledge flows are not restricted in terms of confidentiality concerns • Are in possession of core competencies which are important in relation to competition and relation to customers • Speed up commercialization because of closeness to business needs and market demands • Gives the firm a positive image	• Do not have research activity in-house • Do not have all relevant facilities in house needed to carry out projects • Increased complexity, risk and costs makes in necessary to externalise • Lack of time internally • Reduces fixed costs

7. Policy implications

The ultimate goal of the KISA project is to come up with new ideas to public policymaking. In this sub section, we present a tentative framework for organizing discussions on policy, and discuss some more specific policy proposals related to the four business models presented in the previous chapter. The objective of a policy targeting KISA, provided either internally or externally, is to improve the innovation capability, competitiveness, and efficiency of private firms and public organisations. The focus on knowledge intensive service activities is not an aim in itself; it is a mean to achieve the objective of more innovation, competitiveness, and so on.

The target groups for policy are the providers of knowledge intensive services in general, or KISA inside any kinds of firms. In the following discussion, we will focus on how public policy can either stimulate:

- the supply of KISA (both internal KISA and external KISA),
- the networking between aquaculture firms and KISA providers (both internal KISA and external KISA)
- the demand for KISA (both internal KISA and external KISA).

Such arguments may well lead to a framework as in the figure below, which may be taken as a point of departure for discussing policy issues, and is based on the framework agreed upon in the KISA network. In this framework the supply-side policy includes stimulating knowledge intensive service activities *inside* firms and organisations, and includes efforts towards the creation of favourable conditions for the development KISA suppliers of relevance to aquaculture firms. Demand-side policy, on the other hand, includes supporting demand for internal KISA, and support related to demand for external knowledge intensive services by firms and organizations in general. Network policy targets barriers to networking between aquaculture firms and KISA providers.

Table 20. A framework for discussion of policy implications for the KISA aquaculture study

Targets of policy tools	Stimulate supply and quality of KISA	Stimulate networking	Stimulate demand for KISA
Internal KISA in all types of firms and organisations	Stimulate KISA internally in firms and organisations	Support cooperation between internal users and providers of knowledge intensive services	Stimulate / support the demand for internal KISA from internal users of knowledge intensive services
External KISA providers to all types of firms and organisations	Create favourable conditions for the development of independent providers of KISA	Support cooperation between external providers and internal users of knowledge intensive services	Stimulate demand of firms and organisations for external knowledge intensive services

We will use this framework to discuss what kind of policy tools (related to KISA) that are most relevant in stimulating the innovation capability in the four different types of aquaculture firms. As can be seen from the previous chapter, the different types of firms have very different needs based on their internal knowledge base and the degree of maturity in the organization.

Policy implications Type 1 firm ("The family firm")

These companies are in an immature phase in relation to organisational development and professionalisation. The way they are organised today and the way the framework within which they operate functions, and nor does it seem possible for these types of companies to relate to more types of external KISA than they actually do today.

These firms need to be motivated to strengthen the firms' innovation capability by focusing on competence building of existing internal KISA with a particular focus on training of employees. The approach to qualified labour in the seafood industry is considered in Reve and Jakobsen (2001) in the book "Et verdiskapende Norge " (A value-creating Norway). If compared to other industries, only retail companies place less weight on internal competence development than the seafood companies, according to Reve and Jakobsen. Even though internal KISA are not perceived as important, they are satisfied with the supply of competence into the firms.

There seems to be a need to emphasise the internal KISAs abilities and potential as a driver of innovation in the family firms. "Soft innovations" generated by focusing on organisational development/strategy, training, and project management are only to a limited degree regarded as useful by the family firms. However, the firms seldom have the resources, time, or motivation to focus seriously on "soft innovations".

These firms also need to expand their external linkages, and it seems to be important to use mediators for that purpose, since these firms are small and have a limited search radius. Another challenge is that many of these firms want to cope on their own, and are very sceptical towards external suppliers of knowledge, demonstrating the importance of middlemen that are local and known to the firms. Substantial cultural- and language-related barriers must be overcome in the family firms, if more widespread use of KISA is to be achieved, both internally and externally.

Table 21. Policy suggestions for the family firm

Targets of policy tools	Stimulate supply and quality of KISA	Stimulate networking	Stimulate demand for KISA
Internal KISA	Focus on strengthening internal KISA with a particular focus on how to see new possibilities for dev. besides technological, and on how upgrading of internal KISA can create new possibilities. Focus on general business competence (diagnostic and evaluation support)		KISA for hiring workers to aquaculture firm
External KISA	Professionalisation of local KISA: Must have the ability to translate codified scientific knowledge to the use in firms which mostly relate to practical knowledge in fields like: motivation for innovation, project management, organisation of processes with uncertain outcome etc. In need of KIBS that are specialised towards the sector	Proactive broking that link firms up with KISA of relevance to "soft" input into the innovation process: internal competence building and general business competence	Financial incentives to aquaculture firms for engaging in innovation, both technological and soft Financial incentives for use of KISA in relation to innovation (training of personnel, management of innovation processes, focus on strengthen internal innovation capabilities, focus on use external KISA) Certification of KISA suppliers

Through the interviews we found that the family firm relate to different policy initiatives both in relation to innovation and in relation to use of KISA. Among other things they have taken advantage of the FRAM program of Innovation Norway (former SND). This program seems to have been great help in developing the internal KISA, while at the same time

linking the companies to external KISA suppliers. The participating companies regarded this model, based on cooperation with other companies in the region as well as requiring active participation from the parties, as highly useful. The fact that the service was subsidised was also a motivating factor for the companies. Active involvement and cooperation with the external consultants meant that the participators increasingly felt an ownership to the changes made in the company. The fact that consultants participating in the project are being evaluated both by the participators themselves as well as Innovation Norway assures expert help.

Policy implications Type 2 firm ("The coastal enterprise")

The coastal enterprise also vary according to the use of external KISA in their innovation processes. The most offensive ones, and the ones that were made bankrupt last year, have made more radical changes in the leadership and organization than others, and also seem to be more active users of external KISA, such as KIBS. Others again are more conservative in their use of external KISA, and to a larger degree want to manage change themselves. However, the larger degree of organisational maturity and of vertical integration into the market, has made it necessary for these firms to respond to a larger and more integrated set of demands from customers and the market than earlier. As emphasised in Ørstavik and Aslesen (2004) links between knowledge areas are getting stronger; consumer acceptance as well as production costs are influenced by health considerations. The health of the fish is influenced by breeding, by feed, by medical knowledge and pharmaceuticals, by process parameters such as water temperature, population density, as well as by equipment and handling. To handle such complexities in an expanding industry, there is no escape from developing a broad set of internal KISA and to expand external relations, especially to R&D institutions and public authorities, as well as to higher education institutions. For an aquaculture firm to cope with this complexity, the internal stock of knowledge and KISA must be complex and profound in order for the company to be able to select solutions, development directions, and strategies. Many firms lack the necessary internal KISA and resources to make responses, especially to market signals. This is an impediment to innovation. These firms have become dependent on their external KISA providers, especially the network KISA, to be fully able to understand production processes, and to be able to control the value chain.

Policy of importance to the coastal enterprise's innovative ability should thus be directed at stimulating their internal KISA in areas of business development focusing on marketing and sales. Efforts should also be directed towards raising more analytical knowledge to gain better understanding of how to use research as a tool for product and process development, and to see this in connection with future market demands.

The coastal enterprise (also the science based process industry firms) are acquiring better quality KISA from providers. One interview revealed that there is a large supply of external KISA, particularly in prosperous years. Large professional consultancies as well as private consultants have queued up to provide advice on financial, strategic, and economic aspects of the industry. However, the industry is cyclical, and during periods of economic decline many of these external KISA suppliers, serving the aquaculture industry as a niche sector, disappear. As such, there are few KISA suppliers in the market serving the aquaculture sector alone, according to some of the companies interviewed. This means that many of the actors involved in these periods do not possess sufficient knowledge about the industry, which again means that valuable time is spent educating these consultants in the basic of the industry.

In relation to this, the Type 2 firms do request more research in the field of organisational development, and marketing and market communication. Few public programmes are directed at developing "soft" innovation of relevance to the industry. Rather programs seem to have a narrow focus on technological and biological development.

Innovation Norway was used by several of the interviewed firms as an important contributor to innovation in the firms, both in relation to direct investment support, but also in relation to "softer" input of importance to innovation, such as different types of business courses and training. One of the interviewed firms had also received public money for the marketing of their products abroad.

Table 22. Policy suggestions for the coastal enterprise

Targets of policy tools	Stimulate supply and quality of KISA	Stimulate networking	Stimulate demand for KISA
Internal KISA	Mapping of what internal KISA that is actually needed to develop in relation to innovation Need for marketing and sales KISA (diagnostic and evaluation support)		"KISA for hire" directed at business development
External KISA	Stimulate research directed towards "softer innovation" like organisational development and marketing skills to rise quality of external KISA	Some firms needs proactive broking towards specialised KISA with knowledge of the industry	Financial incentives to engage in long-term innovation projects Financial incentives for use of KISA in relation to innovation

Policy implications Type 3 firm ("Research based entrepreneurs")

These firms are closely connected to KISA developed by the scientific research infrastructure. The question is whether these firms have the internal KISA necessary to be able to commercialise their "new" knowledge, or whether they are able to develop into larger organisations with sustainable value creation activities. Entrepreneur based firms often lack internal KISA in relation to business strategy and marketing skills. Research based entrepreneurs take part in capital intensive and time-consuming projects, and through interviews it was obvious that these firms are in need of long-term and knowledge intensive capital often provided by venture capitalists (KIBS). The interviewed firms said that there were few such actors in Norway.

However, the greatest problem in the Norwegian aquaculture sector, concerned with salmon and trout, is that we have few research based entrepreneurs. There is a difficulty in moving people out from RTOs and into the business world. In general there seems to be a lack of focus on important KISA activities like strategic, technical, and professional advice on how to run a business (or to be an entrepreneur) in research institutes and universities.

The actors employing R&D KISA often take advantage of public measures available of relevance to their activities, in particular tax deduction schemes (SkatteFUNN), and user oriented R&D programs. As such, firms are continuously trying to find schemes and programs that may provide funding for internal KISA. One informant nevertheless found it hard to get an overview of available schemes. Another interviewee suggested to create a gateway as a central source from which firms could obtain information on the different innovation related schemes offered through public institutions and programmes, both in relation to innovation and to relevant KISA providers.

Table 23. Policy suggestions for the research based entrepreneurs

Targets of policy tools	Stimulate supply and quality of KISA	Stimulate networking	Stimulate demand for KISA
Internal KISA	Needs to develop a broader set of business competence internally, especially KISA related to business strategy and commercialisation and marketing Create a gateway of relevant public institutions, programmes of relevance to innovation and KISA		
External KISA	Incentives in relation to supply of long-term knowledge intensive capital towards aquaculture Continuous focus on developing research competence in RTO's	Proactive broking towards KIBS, especially in fields like business strategy and venture capital	Financial incentives for use of KISA in relation to business strategy and development

Policy implications Type 4 firm ("Science based process industry")

Science based process industry firms are uncommon in Norwegian aquaculture today. It appears that the main impetus to create integrated operations, in which heterogeneous knowledge and scientific knowledge relevant at all stages in the value chain, from microbiology to marketing, comes from international firms establishing themselves in the aquaculture industry by way of acquisitions.

These firms' main KISA input comes from R&D efforts, and therefore the most important policy suggestions given in interviews with these actors were related to R&D policy and problems. One of the firms interviewed focused especially on user-oriented R&D programmes and the costs connected to participation in these programmes both in relation to the time it takes to write proposals, adjust to advertisements and application procedures, as well as establish an operative network. Since research topics often are to be tailored to the advertisement, they may not always have the orientation as one would like.

Another problem is connected to the use of public schemes to fund R&D related KISA, that is the aquaculture firms' need to shelter their own core competence against other actors within the industry. Confidentiality is impossible in a system where numerous actors are involved in evaluating the content of applications and their fundability.

As to the aquaculture firms with internal R&D activity, they claim that their greatest challenge in relation to developing internal R&D was that the policy tools in existence only to a limited degree were directed at firms with large internal research KISA. Most of the existing policy tools are directed at SMEs that are not capable of carrying out internal research themselves or lack external linkages. Thus, what kinds of tools should be directed towards the locomotives of the industry? Suggestions from the interviewed firms in relation to the strengthening of internal KISA was to:

1. Provide research departments in private companies with the same funding (basis research funding, strategic program funding etc.) as is available to public and semi-public actors.

2. Direct efforts at strengthening the internal KISA of these companies by allowing them access to literature databases and libraries in the same way as universities.

As regards the supply of external KISA to research activity, the public authorities have acquired one area of responsibility: They are, on behalf of the industry, to assess the knowledge needs of the industry, on the basis of which they are to initiate large scale programs and initiatives, and make sure that the information is conveyed to the industry. Some respondents were critical about this, and felt that this was not the correct way to go about solving it.

Policy tools like SkatteFUNN (tax deduction schemes) do not benefit the larger actors in particular, the deductible ceiling set at NOK 8 mill is marginal for a research company with a turnover of NOK 100 million. The user-oriented programmes also give wrong incentives, according to interviewed firms, since the public and semi-public RTOs work hard to meet the needs of the industries to encourage them to become partners in their R&D projects. Research efforts are also too fragmented, many small milieus carry out research in the same fields. Few research projects are large scale.

The answers provided by the companies in the interviews seem to suggest that what the companies want is the supply of high quality commercial KISA services. This may only be accomplished where there is healthy competition taking place between the actors. Publicly initiated measures may only serve to interrupt the natural "selection process" in this regard. The companies also more generally state that existing policy initiatives are too bureaucratic.

Table 24. Policy suggestions for the science based process industry

Targets of policy tools	Stimulate supply and quality of KISA	Stimulate networking	Stimulate demand for KISA
Internal KISA	Public research programmes directed towards private firms research activity Basic funding to build up internal KISA similar to those within RTOs. Provide access to the same research resources like RTOs have		
External KISA	RTOs are too small and research activities too fragmented, need to build up larger milieus and emphasise large-scale projects to create innovation that generates competitive advantages. Focus on supply of public programmes directed more at "softer innovations" than to biology and technology.	Proactive broker programmes like user oriented research must be closer linked to business needs	Motivate firms' to focus on "softer innovation" inputs to a larger degree by adjusting tax deduction schemes also towards a larger set of KISA purchase (not only R&D)

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Appendix: Interviewed firms

Firm	Contacts	Web	Location
Pan Fish ASA	Lars Christian Blåsternes	www.panfish.com	Rogaland
Marine Harvest Rogaland AS	Nils Viga (Region Director) Ove Martin Grøntvedt (Production leader) Astrid Sande (Manager Administration)	www.marineharvest.com	Rogaland
Nutreco Aquaculture Research Centre	Tessa Tuestad (Controller)	www.nutreco.com	Rogaland
EWOS Innovation AS	Per Olav Skjervold (MD)	www.ewos.com	Rogaland
Pundslett Fisk AS	Kurt Jensen (MD) Bent Eriksen (ass. MD)		Lofoten
Nordlaks AS	Tor Anders Elvegård (MD)	www.nordlaks.no	Vesterålen
Eidsfjord Sjøfarm AS (Sortland)	Knut Holmøy (ass. MD)		Vesterålen
Øyfisk AS (Myre)	Gunnar Klo (MD)		Vesterålen

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