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Increasing competitiveness of the Icelandic fish processing industry

**Addressing environmental and economic concerns through the promotion of preventative
environmental strategies**

**Master's Thesis
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Pollution is nothing but the resources we are not harvesting. We allow them to disperse because we are ignorant of their value.

Buckminster Fuller

Abstract

The aim of this thesis is to increase competitiveness and long range viability of the Icelandic fish processing industry. Fish processing is an important industry in Iceland. Future challenges of the industry include cutting production costs and meeting increased environmental demand. The thesis explores if applying Cleaner Production (CP) strategies can benefit the industry and how the promotion of Cleaner Production in the sector could be facilitated. For that purpose the thesis explores a range of general factors that have been shown to influence the adoption of Cleaner Production in companies, with the aim to identify interesting areas to focus future promotion efforts. As a framework the thesis employs a model of internal and external CP influences with a company as a focal point, aiming to analyse how, and to what extent these factors apply to the Icelandic fish processing industry. Material comes from various sources, but mainly from personal communication with a range of individuals; in companies, within relevant stakeholders and other specialists related to CP work in Iceland. The study finds that CP is a cost effective approach to address environmental concerns, benefiting companies both in terms of improved environmental performance and increased efficiency, leading to less costs. Systematic environmental work seems however not to be high on the agenda in most companies and familiarity of CP often limited. There are furthermore few external factors that work as motivating for the adoption of Cleaner Production. Prices of inputs other than raw material, and non-material outputs seem in most cases not to be strong drivers for systematic environmental work. There is furthermore substantial scope for actors such as authorities, industry associations and universities to actively promote the adoption of CP. A wide-ranging effort to increase value of fish catch in the next years can be seen to create a favourable environment for the promotion of CP. Increased costs of wastewater treatment can also become a point of leverage by providing clear financial incentives for the adoption of CP in companies. Other interesting areas to focus promotion efforts are to increase the familiarity of CP and its benefits among fish processing companies, and to integrate CP into already established quality systems in the companies, among others.

Key words: Fish processing, Cleaner Production, internal & external influences

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1. Introduction

This thesis deals with competitiveness and long range viability of the Icelandic fish processing industry. Fish processing is an important industry in Iceland, and sustaining the industry in the long run means that its development must be shaped by economic, social and environmental requirements. It also involves the constant improvement and assessment of industrial performance. The future of the industry depends on how well these requirements are being met.

Some of the main present and future challenges for the Icelandic fish processing industry are to increase productivity and reduce production costs (Ministry of Fisheries Iceland, 2002). At the same time it can be expected that more pressure will be on companies to improve their environmental performance, in particular regarding wastewater effluents due to increased treatment costs for many municipalities. The companies are also operating on foreign markets, where demands regarding the environmental performance of manufacturers can be expected to increase (Ministry of Fisheries Iceland, 2002). The challenge is thus: how to address environmental concerns without compromising progress in other areas.

By applying preventative environmental strategies in a systematic way, companies have been able to reduce inefficiencies in the processing and reduce the amount of wastes generated. More efficiency means less costs and increased profits, thus benefiting the company both in financial terms and in improved environmental performance. Companies in Iceland nevertheless seem to have been slow to adopt such systematic strategies (Jónsson, 2001). It is thus intriguing to explore if systematically applying such strategies can benefit the Icelandic fish processing industry, and if so: how the adoption process can be facilitated?

1.1 Objectives and scope

The main objective of the study is to explore ways to facilitate the wider adoption of Cleaner Production (CP) in the Icelandic fish processing industry, with the overall aim to increase sustainability and competitiveness of the industry. For that purpose, the study aims to explore a number of factors which have the potential to influence the adoption of CP in companies, in order to identify possible ways to facilitate the process.

The main questions to be answered are:

- Is there potential for the systematic application of Cleaner Production in the Icelandic fish processing industry?
- What influences an Icelandic fish processing company to adopt Cleaner Production?
- How could the dissemination of Cleaner Production in Icelandic fish processing industry be facilitated?

The system which is the focus of this thesis, that is Icelandic fish processing companies and the range of factors that are able to influence their CP efforts, is essentially very complex. The extent to which the system can be understood therefore has obvious limitations. Rather than being an extensive analysis of the factors at hand, the study should be seen as an attempt to provide a picture of CP influences in the context of Icelandic fish processing companies, to identify where further work should be focused when it comes to the promotion of CP in the sector.

1.2 Terminology

The focus of this thesis is on preventative environmental strategies in Icelandic fish processing industry. The term mostly used throughout the thesis is Cleaner Production (CP). The definition of CP can be found in section 3. The **Cleaner Production** term can be understood in different ways. As it is used throughout this thesis however, it refers specifically to the *systematic* and *continuous* application of preventative strategies, with the *determined* goal to minimise wastes and environmental risks from all sources in a company. It can thus be seen as orientation for environmental management, with a focus on waste minimisation and pollution prevention.

As the main focus of the thesis is fish processing on land, as opposed to processing on sea, the term ‘fish processing’ refers to processing ashore, unless stated otherwise.

The term ‘sustainable’ is used in this thesis for a processes which can be sustained or maintained in the long run, taking into account economical, social, and environmental requirements.

1.3 Methodology and analytical perspective

To answer the research questions put forward, the study draws information from various sources, both literature and personal communication. There is limited literature available on companies and environmental work in the Icelandic context, so the bulk of the information was gathered through interviews. Information gathering was carried out in Iceland over two months in summer 2003. It mainly consisted of interviews with a range of individuals, both in fish processing companies, within relevant industry stakeholders, and experts who have been involved in CP related work in Iceland.

The following work is thus to a large extent based on the views of a number of people, and the analytical approach is qualitative. A picture of the situation emerges when many sources point to the same conclusions. If information was contradictory, then additional effort was made to gather more information to fill in the gaps.

To structure and analyse the range of factors able to influence the promotion of CP in Icelandic fish processing industry, the thesis employs a model, with the company as a focal point, and the internal and external influences surrounding it. Figures 3 and 4 illustrate this framework, which will be explored in chapter 5.

1.3.1 The interview process

Interviews carried out in companies were mostly semi structured, based on several questions¹ around which discussions developed. Eight company representatives were interviewed. The interviewees were either owners or managers with overview of environmental or CP work in the company, but often more importantly with good insight in the fish processing industry. Companies were chosen randomly in, or in the neighbourhood of, the Reykjavik area. Size of companies was from small (8-10 employees) to large (100+). The companies interviewed mostly dealt with whitefish; fresh, frozen or salted. Since the names of the companies are not relevant for the study, they will be referred to anonymously, as ‘interviews in companies’. Other interviews were carried out in a more unstructured manner, or with questions tailored for the different actors or experts, in total around 15 interviews. Information was also gathered through telephone and e-mail communication. List of interviewees and other personal sources can be found at the back of the reference list.

When carrying out the interviews, the use of the Cleaner Production term sometimes seemed to cause misunderstanding. This was in particular in some of the companies, but also with some other interviewees. The familiarity of the concept was not always clear. To avoid misunderstanding the concept was briefly explained in the beginning of or during the interviews. This can however have resulted in somewhat less clear and incomplete answers. This has been accounted for to the extent possible in the interpretation of the interviews, and should not have significant affect on the conclusions drawn here.

¹ See Appendix I for questions used as a basis for the company interviews.

2. Introduction to Icelandic fish processing industry

2.1 Icelandic fish processing industry – background information

The focus of this thesis is long range viability and competitiveness of the Icelandic fish *processing* industry, more precisely fish processing on land. To start, it is useful to get an overview of the sector and the larger context in which it exists and operates. The fish industry as a whole constitutes mainly of fishing and processing of the catch. Fish processing is a large industry in Iceland, and is together with fisheries essential for the economy of the nation (see map of Iceland in figure 1). In 2001, Iceland was ranked 12th among fishing nations, with total catch by the fishing fleet measuring around 1.8 million tonnes (Ministry of Fisheries Iceland, 2003 [Online]). With a population of only around 280.000 inhabitants, Iceland becomes the number one nation in terms of fish catch per capita. Its 2001 export of fish products accounted for about 62% of all export revenues, and the economical prosperity of the country is closely linked to the development of the fish industry. (Ministry of Fisheries Iceland, 2001 [3])

Almost all fish products are exported; main markets are Europe (68-72% of export value), North America (15-18%), Asia (8-12%) and other markets (5%) (Ministry of Fisheries Iceland, 2001 [2]). The quantity of exported marine products was approximately 807.000 tonnes in 2002 (Statistics Iceland, 2002 [online]). Processing takes place in a number of municipalities in regions around the coast. Table 1 shows the relative distribution of catch by region of processing. Table 2 shows the relative quantity and value of exported marine products by product categories in 2002. According to ISAT95, classification of economic activities in Iceland, there are around 300 companies listed under the category of ‘fish processing’², including fishmeal and fish oil factories³. These companies vary in size, from small (5-10 employees) to large (350-500 employees). In many cases there is direct relationship between fishing and processing operations, since both operations can be within the same company.



Figure 1. Map of Iceland (From: Microsoft Encarta World Atlas 2002)

Region	%
Whole country	100.0
Capital region	7.0
Southwest	13.2
West	7.6
Westfjords	3.5
Northwest	5.7
Northeast	14.0
East	34.7
South	11.7
Abroad	2.7

Table 1. Relative distribution of catch by region of processing in 2002 (Data from: Statistics Iceland, 2002)

² Fish processing, category 15.20 in ISAT95. The ISAT95 classification is based on NACE, Classification of Economic Activities in the European Community

³ ISAT95 information acquired from Lánstraust ehf.

The fish industry as a whole has gone through rapid changes over the last decades, both in terms of technology and operational environment. The industry is now considered technologically advanced on an international level. Traditionally most processing has taken place on land but in recent years processing on sea has become increasingly important, even though majority of the total catch is still processed on land. The processing sector is inevitably dependent on a stable supply of fish and the size of fish stocks. (Ministry of Fisheries Iceland, 2001 [2]) Period of over fishing and diminishing yields in the 1980s and 90s was difficult for many companies. This led to the development of a fishery management system which has since 1990 been based on individual transferable quotas (ITQ). The fishery management system applies a precautionary approach, and quotas are decided annually based on best available scientific data (Ministry of Fisheries Iceland, 2003 [online]). While the adoption of the quota system has resulted in better management of fish stocks, it has also been a matter of debate regarding the distribution of quotas. Quotas are able to move from one region to another, which can affect the processing industry. This, together with changed processing patterns, where more of the catch has been processed offshore, has recoiled upon a number of the land-based processing enterprises. The development has been that some sub-sectors have been growing, such as those exporting fresh fish and salted fish, while the share of others has been diminishing, such as of those processing frozen fish on land. (Ministry of Fisheries Iceland, 2001 [2]) However, despite some tumultuous times, the fish-processing industry has been and continues to be very important for the economy of the nation, and is crucial for the settlement in many parts of the country.

	Quantity (% of total export)	Value (% of total export)
<i>Frozen</i>	31.0	50.9
<i>Salted</i>	7.1	17.7
<i>Fresh and chilled</i>	11.8	11.0
<i>Dried</i>	1.7	2.3
<i>Meal/fish oil</i>	45.6	16.8
<i>Canned goods</i>	0.3	0.9
<i>Other</i>	2.4	0.3

Table 2. The relative quantity and value of exported marine products by product categories in 2002 (Data from: Statistics Iceland (2002))

2.2 Sustainable development of the sector - Future challenges and opportunities

Over the last decades, the demand for sustainable use of natural resources has become ever more important, and that economical growth must not jeopardise the quality of the environment. In practise this means that individuals and organisations must utilise natural resources in a responsible way, not jeopardizing the possibility of future generations to fulfil their needs. (Miller, 2000) The long term sustainability of the fish processing sector depends on how well it performs economically, socially and environmentally. This section will discuss the main challenges and opportunities facing the fish processing, in particular those related to the economical and environmental performance of the sector.

There is considerable potential for the future development of the processing sector, and the fish industry as a whole in Iceland. A work group constituted by the Ministry of Fisheries has estimated that the value of fish caught has the potential to almost double in the next 10 years. This is to be achieved through reduced costs, increased productivity and increased value of the catch. Changes will have to take place throughout the value chain, which is from catching the fish to the final product, and calls for innovative solutions in many fields, including fish processing. (Ministry of Fisheries Iceland, 2002)

To reach these future potentials in the fish industry, the Ministry of Fisheries has initiated a 5-year effort, bringing together authorities, the industry and other stakeholders, in order to analyse where work must be done. Achieving these goals requires coordinated work in many fields, including education, research, development of products, including new by-products, marketing, improved work methods and technologies and much more. (Ministry of Fisheries Iceland, 2002)

Regarding the processing sector, it is mentioned among other things, that production costs have to be reduced substantially, due to increased competition from countries with low wages. (Ministry of Fisheries Iceland, 2002) The general operating conditions of the processing have often been considered rather difficult for various reasons. For example due to movement of, and fluctuations in quotas and more processing being done on board processing trawlers. This has been reflected in generally higher returns for those processing the catch on board processing trawlers than in land based processing factories. (Ministry of Fisheries Iceland, 2001 [2]) Increasing the profitability of the land processing is therefore a challenge that will be important in the coming years.

It can therefore be said that the near future for the fish industry, including the processing and related sectors, will be both challenging and dynamic, with much need for innovation and new solutions. On the company level, this means not only that companies must be aware and open for new opportunities, but also must strive to optimise their operations, with maximum productivity and *overall* efficiency.

For the fishing industry as a whole, sustainable use and conduct of natural resources is crucial. Sustainable use of fish stocks is therefore a fundamental concern for Iceland, and is controlled through a fishery management system based on individual transferable quotas (ITQ). There is consensus among all parties, authorities, fishermen and scientific community that all measures must be taken to ensure sustainable use of fish stocks. In that sense the Icelandic fishery management system has also been more successful than many others. Most focus regarding the sustainability of Icelandic fish industry has thus been related to the management of fish stocks and conduct of the ocean, and Icelandic authorities have exerted themselves for protection of the oceans and effective fisheries management internationally.

Environmental impacts can occur over the whole lifecycle of the product, and are related to all natural resources used in the process, materials, water and energy. As with the fishing as such, the well-being and future of the fish processing industry depends on the availability of limited and clean natural resources. Issues concerning the responsible use of natural resources and minimisation of wastes are furthermore becoming more and more important internationally. It can be expected that demand from consumers regarding the environmental impacts of a product and how it is made will increase in the years to come. This can result in increased pressure on those responsible for the processing, as well as those responsible for the fisheries, that their environmental conduct and use of natural resources is managed in a systematic way (Ministry of Fisheries Iceland, 2002). The competitiveness of a company will therefore also be determined by how well they manage the environmental aspects of their operations.

It has been mentioned that the production of fish products must be environmentally sound, and sustainable, due to the importance of the fish industry for the nation. This is also significant in terms of fulfilling the possibly increased demand for, and concern over, the environmental impact during a products lifecycle. The fish industry can expect having to meet these demands in various ways. Ministry of Fisheries Iceland (2002) has stated:

- That the industry issues a code of conduct regarding its use of natural resources and how it plans to be sustainable in the long run.
- Measuring the environmental impact of the industry.
- A neutral actor publishes an environmental report assessing the situation at each time.
- Increase the ratio of production for human consumption, since consumers have less understanding of fishing one species as a fodder for another.

It is therefore important that the future development of the sector does not in any way cause a threat to the environment, and that the use of all natural resources is managed in a responsible way. Furthermore companies must be able to demonstrate that they deal with the environmental aspects of their operations in an organised way. Discussion about environmental issues and fish industry has largely been regarding the management of fish stocks, but how companies deal with their environmental aspects has not been as high on the agenda. Limited focus on environmental management is true for Icelandic enterprises in general (Jónsson, 2001). To be

sustainable it is a prerequisite that enterprises know the environmental aspects of their production and seek systematically ways to reduce waste and excessive use of materials and energy. Such work has also been shown to give a better overview of the process and result in reduced costs and increased profits in many cases (Eyjólfsdóttir, 1997).

A study by Eggertsson (2003) illustrates that 7 out of 10 managers in fish processing companies believe that customer demand regarding environmental work in companies will increase in the years to come, and 9 out of 10 believed that environmental demand from authorities would increase.

It is thus important that companies start giving more consideration to their environmental work. Companies that don't do so, risk becoming inferior to others regarding how well they can meet increased environmental demand. By applying preventative strategies it is possible to reduce waste at source and increase efficiency. An innovative operational environment in the coming years provides an excellent opportunity to increasingly take environmental concerns into account, and put environmental work on the agenda in companies, alongside changes in technologies and working methods.

2.2.1 Main environmental concerns for fish processing companies

Environmental factors in companies are related to the inputs used for, or in the processing, and non-product outputs which are released into the environment. For fish processing in general, some of the main inputs, in addition to the raw material, are cleaning materials, packaging, water, energy (including hot water), refrigerants and oils. The main non-product outputs are effluents, in particular wastewater with potentially high organic content, solid wastes such as plastics, corrugated cardboard and pallets, and possible leakage of refrigerants and bad smell for example. The most important of these are in particular wastewater with high organic content, raw material utilisation, use of water and energy. (Bjarnadóttir, 2002; Eyjólfsdóttir, Yngvadóttir 1997)

Fish processing is one of the main sources of industrial sewage water in Iceland, and most wastewater from the industry is discharged untreated to the ocean (OECD, 2001). A big fish processing facility can release around to 10-20 thousand personal equivalents (p.e.) of organic material in their wastewater. This is an increasing concern for many municipalities, in particular for many small municipalities where effluents from fish processing can be manifold those from households. (Stefánsson, 2003) The concern of local authorities is to a large extent economical. European legislation⁴, which Iceland is committed to as a member of the European Economic Area (EEA), requires that urban wastewater be treated before it is released into the ocean. This requirement does in many cases call for the installment of expensive pumping- and/or treatment facilities. Such facilities have already been installed for most municipalities in the capital area, but excessive costs have delayed constructions in many of the smaller municipalities around the country, where fish processing is often a large industry. (Fráveitunefnd Umhverfissráðuneytisins, 2003)

Local authorities are therefore becoming increasingly concerned about the amount of wastewater released from industries, and that companies either participate in the cost of such treatment or take care of their own wastewater. There are also examples where organic material from fish processing has caused problems in treatment facilities. In an assessment issued by Local Agenda 21 in one of the municipalities in the capital area Steingrimsdóttir (1999 [online]) writes:

Wastewater issues in companies are not adequate. Waste from fish processing companies seems to be released directly into the sewage system, which then has to be treated and is an expensive problem for the treatment facilities.

⁴ EEA directive. 21. May 1991 concerning urban waste water treatment. (91/27/EEC)

And in a 2002 report issued by environmental authorities in two municipalities in the capital area, Hafnarfjörður and Kópavogur, it says:

Water effluents have recurrently caused problems in waste water treatment- and pumping facilities for the municipalities. Odour from fish processing has also caused a nuisance. // Companies must also tackle their refrigerant issues. (Hafnarfjörður and Kópavogur Health and Protection office, 2002)

In an assessment of environmental conditions in east of Iceland, issued by Agenda 21 for municipalities in the area, it is stated among other things that wastewater issues from fish processing are often not dealt with in a proper manner. Pollution control is said to be insufficient or unreliable in many cases. Incidents where waste from fish processing is accidentally released into the ocean are also common. In some cases this is material with potential value, and thus important to prevent this from happening. In addition, wastes sometimes end up on shore where it attracts vermin. (Agenda 21 Fjarðarbyggð, 2000)

Water use becomes an important issue in relation to the wastewater released. The amount of wastewater generated is directly related to the inputs of water. Water use has usually not been an important consideration in Iceland, due to low prices and under emphasis. The amount of wastewater, and thus the amount of water that has to be managed or treated, increases in relation to the amount of water used. Most companies are very much concerned about their raw material efficiency, but it is also important to realise that more water flow can result in more loss of material. Water efficiency together with raw material efficiency are therefore both important considerations when it comes to reducing wastewater. (Eyjólfsdóttir, Yngvadóttir 1997)

It can therefore be expected that companies will be increasingly required to deal with their environmental aspects in an organised way, and reduce waste at its source, to minimise the load and reliance on end-of-pipe measures. Increased cost of wastewater treatment for municipalities can weigh heavily in that respect. While some end-of-pipe measures may still be required, the focus should be on preventing the generation of waste at source, to all extent possible. Companies can apply preventative environmental strategies to gain an overall increase in efficiency and reduce the generation of all wastes.

3. Preventative environmental strategies – Cleaner Production

Applying preventative environmental strategies means tackling environmental problems at their source. It is ultimately the most sustainable way of environmental protection. The first strategy to deal with wastes or pollution from industries was dilution, at that time ‘dilution was the solution to pollution’, seen in practise as higher chimneys and longer effluent pipes. When this was considered insufficient, ‘end-of-pipe’ solutions became the norm, meaning that wastes were captured ‘end of pipe’, before they entered the environment. This entails the treatment and disposal of the subsequent substance that has been captured. These methods often lead to added costs, and the perception that environmental protection is necessarily costly. ‘End of pipe’ methods also have in common that they treat waste without considering its source. All waste can be regarded as lost raw material; something that is bought for the production of the product, but ends up as waste because of inefficiencies in the production. This concept gave rise to Preventative environmental strategies. These strategies focus on tackling waste and pollution at its source and reducing inefficiency in the production, and thereby provide a clear economic incentive for environmental protection. (Rodhe, 2000)

However, it should be noted that the three strategies mentioned above are not mutually exclusive, but can all be used to different degrees in an enterprise. A forward-looking company should however seek to apply preventative measures before relying on end-of-pipe or dilution measures, which may be more expensive in the long run.

United Nations Environmental Programme (UNEP) has since 1989 used the term ‘Cleaner Production’ to promote Preventative environmental practices, and has adopted the following definition for Cleaner Production:

Cleaner Production is the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency, and reduce risks to humans and the environment. Cleaner Production can be applied to the processes used in any industry, to products themselves and to various services provided in society. (UNEP, 2003 [online])

The Cleaner Production concept assembles aspects of numerous other very similar but slightly different terms and strategies that have appeared. These are for example: *Waste minimisation*, *Pollution prevention (P2)*, *green productivity*, *Design for the Environment*, *Industrial Ecology*, *Eco-efficiency* and *Environmentally Sound Technologies*. (Meima, 1999; UNEP, 2003 [online])

Preventative environmental measures reduce overall resource consumption, and by that contribute to sustainable development. The reasons for inefficiencies can be either technological or managerial. CP measures therefore aim to reduce waste at source through changed input materials, better housekeeping and operational methods, process technology and internal reuse and recycling. Measures can range from simple and low-cost measures to high tech measures, involving large investments. (Rodhe, 2000) It furthermore assists the company to become more productive, innovative and profitable (Pojasek, 1999).

The key to the success of CP is that it is implemented *continuously* and is process *integrated*. This entails that it may be somewhat more complex than end-of-pipe measures, involving more actors and processes in the company. It is however more rewarding, since the work can entail cost reductions and a generally better overview of the process and the flow of materials. Practicing preventative strategies can therefore result in a win-win situation, benefiting the company both environmentally and financially, and thus give competitive advantages. (Rodhe, 2000)

A Cleaner Production program can only be regarded successful if it “forms the start of an ongoing journey to environmental progress”. The success can thus not only be measured in terms of less environmental burden. Awareness of the people involved, willingness for continuous improvement, the learning ability of the company and their innovative abilities, are also important success factors. (Zwetsloot, Geyer, 1996)

3.1 How does Cleaner Production work?

In principle, CP is implemented in a parallel way to quality management systems. It is integrated in the internal processes of the company, is continuous and involves employee participation. After identifying the need for waste minimisation or to increase efficiency, the starting point is usually to carry out a *Cleaner Production assessment*. (See figure 2) The assessment is a crucial step from the recognition of the need for CP measures to the implementation of measures to solve the problems. The assessment involves the analysis and mapping of the process and the flow of material inputs and outputs, in order to find the roots of inefficiencies and options for improvement. A feasibility study is typically carried out for those options that are not obviously feasible, to prove whether they are technically, economically and environmentally feasible. The feasible preventive measures are then implemented and measures taken to ensure the ongoing application of Cleaner Production. (UNEP, 2000)

There is a set of tools that are useful in the CP work. Many of these tools furthermore have their origin in quality improvement systems. Making process maps is for example useful in order to enhance the overview of the process. These should preferably be put together by people from different functions in the company. Process maps depict the aspects of the process as an array of boxes, and the flow of material in and out of each box. These maps can serve as templates for collecting information on resource use and loss of resources throughout

the process. They also make the CP opportunities more visible and easier to grasp. Process maps are yet simple, but can include many levels of detail. (Pojasek, 1998)

Another important tool in CP work is benchmarking. In order to see the improvement potential in a process, it is useful to compare the consumption of material and energy in the process to what has been achieved in similar industrial processes external to the company for example. Demonstration projects are another source of information regarding the potential for improvement. Two CP demonstration projects have been carried out in Iceland, one of them in six fish processing companies. As will be discussed in the following sections, these show that applying Cleaner Production can have direct benefits for companies, improving management overview of the process, increasing efficiency and improving environmental performance and awareness in the companies.



Figure 2. Cleaner Production assessment procedure (UNEP [2], 2003)

It is important that companies are able to use these and other tools themselves, to be able to implement and sustain CP efforts in a company.

3.2 Sustaining CP efforts in a company

A crucial part of the CP process is that it aims for continuous improvement and is sustained within a company. Pojasek (1999) mentions that a common problem with many companies' CP efforts is that at some point the CP work becomes less active or even comes to a complete halt. A common approach to initiate a CP programme has often been with the main focus on the CP assessment, directed by an external consultant and bringing together people from several functions in the company. A plan for implementation has then been made based on the assessment, and the programme expected to evolve and sustain the CP plan and efforts in the company. (Pojasek, 1999) The 'hope' has been that once started, a company would "see the light" so to say, and continue the waste minimisation efforts on its own. This has however rarely been the case. (Pojasek, 1998) The problem has often been that the CP plan has been limited to what was covered in the assessment, which then makes continuous improvement difficult. Furthermore CP efforts were not integrated in quality and other production activities, ending up as a separate program. A single assessment is thus not enough to make the CP program work in the long run. It has to be effectively planned, organised and controlled in some way. (Pojasek, 1999)

For a CP effort to sustain itself there is a range of factors that need to be addressed. As with quality management, the commitment of top management is essential for the continuation of the program. The implementation plan must furthermore include a vision statement and goals to be achieved. For every goal a strategy must be set forward. Striving for continuous improvement is also essential, to be oriented on finishing single CP projects is thus not enough. The company must take the knowledge gained from one project and use it to address other waste prevention opportunities in the company. (Pojasek, 1999)

One alternative is to integrate Cleaner Production with already existing quality improvement programs in the company. According to Pojasek (2002), integrating lessons from quality systems may be one of the most successful approaches. The definition of waste is however not the same in the two approaches, and quality

systems alone do usually not strive for reduction of environmental wastes. Quality improvements have however often been shown to be better integrated in the core operations of the company and focused on its performance. The problem with CP is that it often ends up as a stand alone program, and the visions and goals necessary to keep the program running are not known and practised by the employees. Quality objectives are also related to the core business practises of the company. This is essential for the success of CP, that it becomes a part of every business decision taken on a day to day basis. (Pojasek, 2002) Merging CP and quality improvement systems may thus be an attractive approach.

4. Potential for Cleaner Production in the fish processing industry

To assess the real potential for Cleaner Production in an industry, one would optimally need to have a comprehensive overview of the performance of companies, and then compare it with some best practices. There is unfortunately very limited information available regarding the environmental performance of companies in the Icelandic fish processing industry. Companies may furthermore differ substantially in terms of their CP performance, and thus the potential for improvement. The CP performance will also be determined by a range of factors, related to the technical and organisational systems in the companies for example. To see the full potential one has to look more thoroughly at how a company operates and how its internal systems work, in terms of technology, management etc., as is the objective of a CP assessment.

One way to estimate if there is potential is to look at examples of CP work that has previously been undertaken in Icelandic companies. If these examples show that there is potential, one can assume that potential can also be found in other companies, and that they are not (at least not all) operating perfectly efficiently.

4.1 Experiences from demonstration projects carried out in Iceland

Two Cleaner Production demonstration projects have been carried out in Icelandic industries, and both indicate substantial benefits of such work. The former project was carried out in 1992 in five manufacturing companies in different industry sectors. (Jónsson, 1994) The second was implemented in eight food-processing companies in the years 1994-1996. (Yngvadóttir et al., 1997)

The former program was initiated by the Technological institution of Iceland, with the main objective to “introduce and assess whether the methodology of *waste minimisation opportunity assessment* [CP assessment], can be applied within Icelandic conditions, and [t]hereby reduce the amount of wastes and implement cleaner technology.” (Jónsson, 1994) Similar projects had been implemented in other Scandinavian countries with very positive results. It was therefore interesting to see if applying the methodology in Icelandic companies would lead to the same benefits as seen in foreign examples. In particular whether savings could be achieved in Iceland, where environmental demands and charges for environmental pollution were relatively low. (Jónsson, 1994)

Of 97 tasks that were identified in the assessment, 38 were chosen for further work. Most of the operations to solve the tasks, involved changed work procedures and good housekeeping (28), 12 operations involved new techniques, 7 onside reuse/recycling, 6 offside reuse/recycling, in one case a substance was replaced, and 5 operations dealt with public image enhancement. (Sometimes more than one operation was needed to solve a task) The main conclusions were that the methods of Cleaner Production (technology) could be applied successfully in all the companies. In addition to environmental benefits, costs could be reduced considerably in many fields, thus benefiting the companies economically. (Jónsson, 1994)

The second and more recent project⁵ was carried out as a part of Nordic cooperation and was lead by the Technological institute of Iceland (Icetek) and the Icelandic Fisheries Laboratories (IFL). The project was titled

⁵ Note that when referring to a demonstration project later in the text, it always refers to this project, since it involved fish processing companies.

‘Cleaner Production in Food Industry’, involving eight food-processing companies, and thereof six in the fish processing industry. The aim of the project was to carry out Cleaner Production assessments in the companies and to implement Cleaner Production strategies to reduce the emission of wastes to the environment, reduce the use of water and energy and improve raw material efficiency. The implementation of the projects was started by forming environmental groups of 2-6 people with different responsibilities in each of the companies. The group members were also required to have the authority to implement certain changes or observations. All the group members sat a one-day course about Cleaner Production, CP assessment and environmental discussion in general. The groups then, together with consultants, analysed the material flows in the companies, detected areas that needed improvement, and prioritised tasks. Of total 161 tasks that were identified in the 8 companies, 51 were taken for further work. 20 dealt with changed work procedures, 15 collecting information/monitoring, 5 with less use of materials, 2 with environmental policies, and 9 dealt with reuse/recycling in the companies. A number of tasks were also identified for future examination. Most of the companies chose to focus on the use of energy, water, material utilisation and effluent issues. (Yngvadóttir et al., 1997)

The results of the project were very positive. The work in these companies resulted in more efficient use of raw materials, leading to less production of waste, less use of water and energy, handling of solid waste was improved and there was an increase in reuse and recycling. Among the results was a 40% reduction in water use for a fish processing company, savings of annual costs for detergents were cut by 24% by analysing cleaning routines for a plant, substantial savings in heating costs was achieved by utilising waste heat, and raw material efficiency was increased by 0.5% in several cases to mention a few. The work did in almost all cases lower costs and increase environmental awareness in the companies. Furthermore the payback time for investments was usually short, 2 to 3 months. The project concluded that with CP it was clearly possible to achieve cost reductions and improve environmental performance at the same time. (Yngvadóttir, et al, 1997)

Both these examples show that there are benefits of systematically implementing CP strategies in Icelandic companies. In all cases there was furthermore found to be substantial potential for improvement. This is true both for fish processing companies, which are the focus of the thesis, and for companies in general. The CP work furthermore, did in almost all cases, result in cost reductions and/or added value due to increased efficiency of material use, and less waste generation.

4.1.1 More about the CP demonstration project – continuation of CP work

Experts involved in the CP work in the fish processing companies, mentioned that the companies were generally very satisfied with the results. How well the companies did in their CP work was however to largest extent related to the interest in the companies. If the participants were interested, then the work went more smoothly and results were better. It is very important to have people within the companies that are interested in driving such work; preferably this should be the top management. An important external driver for participation in the project was increased environmental demand from customers in some of the companies; other external drivers were not mentioned. The main driver for the CP work didn’t come until the companies could see that they could really save money. Quantifiable information about the flow of material, gathered during the initial assessment of the processes, brought to the surface many inefficiencies, many of which caused surprise regarding how much was being wasted. Just bringing together people from different places in the company brought to the surface things that had clear improvement potential, but had not been communicated. (Yngvadóttir, 2003 [personal interview])

As mentioned earlier, the overall success of a CP project must be judged on more factors than only environmental benefits achieved during the time of external assistance. Even more important is that this work continues and is integrated in the internal processes of the companies. The company must have the interest and capacity to continue the CP work on its own. (Zwetsloot et al., 1996)

In this respect, the results are less clear. Only one of the fish processing companies committed itself to further CP work by issuing an environmental policy, mentioning that it would work according to the principles of Cleaner Production. It is very possible that the CP work in many of the companies became less systematic, or discontinued after the official demonstration project ended. Dissemination has also been very slow, “which is rather disappointing, since it is a method that is easy, comfortable and works, regardless of the size of the company”. (Yngvadóttir, 2003 [personal interview])

To gather more information on the continuation of CP work in the companies, after the demonstration project ended, a short follow up survey was carried out. Short online questionnaires⁶ were sent to the six fish processing companies that had participated. The companies were asked if they had continued the CP work which was started during the official project, among others. Four replies were received, and from two companies answers were gathered through phone. Out of the four replies, two answered ‘yes’, one said ‘partly’ and mentioned that the work had been inactive for some time after the project ended, but was now being taken back on the agenda. One company replied ‘no’. From the other two, the answers could be understood as ‘yes’ and ‘partly’. The questions did however not ask how integrated or systematic the work had been. They seem however to be mainly project based. All the companies could mention some CP projects that had been implemented. All the companies mentioned the main driver for implementing CP projects to be mainly financial, and demand from environmental authorities was also important. Three companies mentioned that the company was also thinking about its image. The company which had not continued mentioned lack of follow-up as the reason. 4 out of 5 companies mentioned the need for more external motivation or pressure to sustain CP activities; one company did not answer.

It seems thus that the continuation has been mixed, and in some cases the work has come to a complete halt, at least temporarily. They answers also indicate need for more external pressure or motivation to sustain the CP work. One mentioned for example the need for an actor who provided good examples and solutions for companies. It would however be interesting to know in more detail how actively the CP work is carried out in the companies, how integrated and systematic it is, how extensive and regular monitoring is, and so on.

4.2 *The potential today*

The CP projects in the fish processing companies were carried out approximately 8 years ago. One can ask how much has changed since then, and if this potential still exists. It was mentioned above that dissemination of CP has been slow. Also regarding Icelandic enterprises in general, it has been stated that there has been little initiative from companies to deal with their environmental matters in an organised way. Over the last decade little has changed regarding environmental work in companies. Positive results from organised environmental assessments in companies 10 years ago made people think that enterprises “would stand in lines waiting for environmental assessments”, and the reputation alone would be enough for its dissemination. This has however not been the case. (Jónsson, 2001) In a newsletter about environmental- and security issues in fish industry it is also mentioned that environmental issues in fish processing companies are often “unclear and disorganised, applying to the handling of wastewater, use of water, energy, surrounding environment and environmental management.” (Bjarnadóttir, 2002) A survey made by Eggertsson (2003) points to the same; that issues concerning the company’s environmental matters is not high on their agenda. (Eggertsson, 2003)

The company interviews indicated that while raw material efficiency seems always to be the first concern for the companies, other aspects such as water and energy etc. seem to receive less emphasis in many cases. Monitoring is thus often inadequate. (Interviews in companies, 2003) Interviews with experts support this. (Yngvadóttir, 2003 [Personal interview]) The concern is thus that the potential to increase *overall* efficiency in the process, including water, energy, and other material efficiency, remains unexploited.

⁶ The questions used are presented in Appendix II.

4.2.1 CP potential in the context of future challenges and opportunities

One of the main future goals of the fish industry is to increase the value of the fish caught. Part of that vision is to lower production costs in fish processing. (Ministry of Fisheries, 2002) At the same time companies can expect to see increased demand regarding their environmental work, both from customers and authorities. Companies must be able to manifest that the manufacturing of the products is done in an environmentally responsible way. It is therefore important that meeting environmental concerns does not hamper cost reductions in the process.

Implementing Cleaner Production supports these goals. This thesis will not argue that implementing preventative environmental strategies in the company will solve all challenges facing a fish-processing enterprise. The benefits are nevertheless clear, as almost all experience of such work has shown. It gives a better overview of the process, improves the management of resources used, and ensures that environmental concerns are being met through maximising overall efficiency.

While CP work does in most cases entail cost savings it should be acknowledged however that opportunities for short or medium term profits can be expected to vary across companies and the environmental issues at hand. What is certain however is that Cleaner Production offers a more cost effective means of dealing with environmental concerns. It is also important to acknowledge those benefits that are often less obvious, such as improved health and safety, more motivated workforce, improved public profile, and decreased liability, to mention some. (Gunningham, Sinclair, 1997) It should also be realised, that options other than implementing Cleaner Production can be perceived more attractive if the only aim is to make money (Reijnders, 2003). It is thus valuable to put additional emphasis on these less obvious benefits that CP can offer.

The concern has also been raised that the organic matter that is released from fish processing is easily diluted, and does not cause any harm when it reaches the ocean. It is thus not necessary, nor sensible, to invest in expensive wastewater treatment in small municipalities where main industry is the fish processing industry. It is however mentioned at the same time, that companies should use Cleaner Production to minimise their wastes before they are released. (Stefánsson, 2003) This is a valid concern, since conditions in Iceland may indeed differ from those in Europe, where the urban wastewater directive originates. Authorities have however stated that minimum requirements for wastewater treatment will be enforced, according to the EEA directive (Fráveitunefnd Umhverfisstjórnunar, 2003).

Others have also pointed to the potential value of the material that is released. It has been stated, that every year, around 10.000 tonnes of dry organic matter is released from fish processing with wastewater. It has been argued that much of this material could be utilised, for example to produce organic fertilizer for agriculture, or for making fuel for use on cars. Such initiatives would not only be to increase profits, but also be positive for the image of the whole sector. (Halldórsdóttir, Kolbrún et al., 2000 [Online])

4.3 Concluding the potentials

Experiences gained from CP demonstration projects in Iceland point to clear benefits of applying Cleaner Production strategies. By systematically applying Cleaner Production it is possible to increase the overall efficiency in the processing, achieve better environmental performance and reduced costs, among others. What is less clear is the continuation of the projects in the companies after the demonstration project ended. The dissemination of CP also seems to be very slow, despite very positive results of such work. Demonstration projects alone are thus not sufficient to trigger the wider adoption of CP in companies.

While the saving potential can be expected to differ between companies, types of processing etc., the demonstration projects illustrated substantial saving potentials for all the participating companies. Savings in detergent and soap purchasing were for example in the range of 5-24%, increase in raw material efficiency

around 0.5 % in several cases, and water savings were up to 40%. (Yngvadóttir et al., 1997) Cleaner Production thus offers a cost effective means of dealing with environmental concerns, and thus concurs with the future challenges of the fish processing industry, which include lowering operational costs, and meeting more environmental demand, among others.

5. Factors influencing the adoption of Cleaner Production in companies

If there are in almost all cases positive results from the systematic implementation of Cleaner Production in companies, as most cases imply, one wonders why not more companies have adopted such strategies? The question then also rises, how can the adoption and implementation of CP be facilitated? In that context it is important to realise that companies do not operate in vacuum. There is a range of factors, both internal and external to the company that have the potential to influence how they act and perform, and thus also influence CP efforts in the company. The extent to which these factors will be encouraging for the adoption of CP will differ, and the question is mainly whether any of these factors are motivating for CP adoption or not. In that context it is also interesting to consider how these influences can be affected, and the role of different actors in that respect.

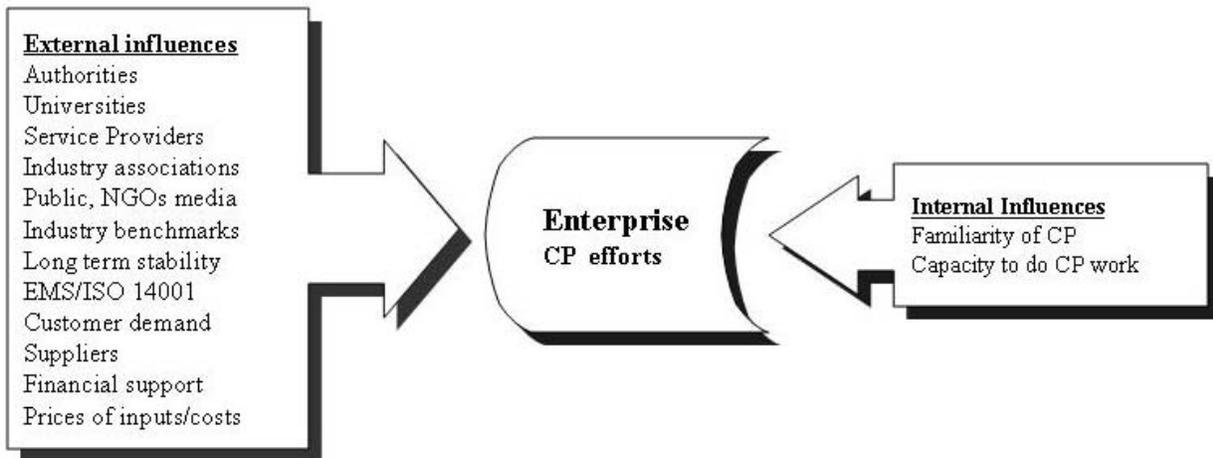


Figure 3. Factors able to influence CP efforts in companies (based on Rodhe, 2000 (adjusted))

Figure 3 presents a list of general factors that have been shown to influence CP efforts and promotion in companies. The aim of the following sections is to analyse how and to what extent these general factors apply to the situation of the Icelandic fish processing industry. The main interest of the study was on the factors presented in figure 3. Section 5.1 will discuss some internal CP related influences, and external influences are discussed in section 5.2.

It is not the aim of this section to provide an exhaustive analysis of these factors. Rather, this section will provide a snapshot of the possible influences, based mainly on the availability of information, time limits during the study or the perceived relevance of the factors. The following discussion draws information from various sources, literature and personal communication with various actors related to the sector, stakeholders and companies.

5.1 Internal factors influencing the adoption of Cleaner Production

Internal factors that can influence CP efforts in companies are for example motivation and attitudes towards environmental work, management capacity, technical and financial capacities among others (Rodhe, 2000). This

section will briefly discuss some of the CP relevant internal factors which were revealed during the study. The main focus was on how familiar companies are with the CP concept, but the interviews also revealed other factors, such as in terms of the internal capacities in the companies. The world business council on sustainable development (WBCSD) has mentioned that some of the main barriers to adopting CP is that the CP concept is not known to industries, and if it is known, the benefits of CP work have not been communicated, or appreciated by the company (WBCSD, [online]).

In terms of the internal capacity in the companies, it is important to distinguish between small and medium sized companies (SMEs) and those that are big. According to Lefebvre et al. (2003), large firms usually have more capacity, both financial and non-financial, to integrate environmental concerns into the lifecycle of their products. They are furthermore subject of more external pressure from surrounding actors because they are more visible. While the capacity of SMEs is in this context usually less, it can also be said that these companies are often more flexible, and may adapt to changes more rapidly. Size can thus play a double role. (Lefebvre et al., 2003)

5.1.1 Environmental work, familiarity of Cleaner Production and CP capacity in companies

The information collected throughout the study indicates what seems to be a limited focus on systematic environmental work in fish processing companies. Interviews with actors that have been involved in Cleaner Production and the promotion of CP revealed that companies in general do not show much interest in such work. While there are some companies that have initiated efforts to deal with their environmental issues in an organised way, environmental work seems not to be high on the agenda of most companies. (Interviews in companies, 2003; Bjarnadóttir, 2003 [Personal interview])

The size of the companies can also be relevant in this respect. Many of the companies referred to in the last paragraph are relatively small, and often there is only one person taking care of the management. They are simply very busy in their daily operations, and there are issues other than environmental work which are considered more important. There may also be issues that demand much attention, such as regarding quotas and the availability of raw material. This can thus be reflected in little interest in these matters. (Bjarnadóttir, 2003 [Personal interview])

A study by Eggertsson (2003) supports what seems to be little focus on environmental work in fish processing companies, finding that environmental work in the companies is “surprisingly undeveloped and not organised”. However the study does not point to a special relation to the size of the companies in this regard, there are some small companies that seem to make substantial effort, while there are also big companies that do not.

The company interviews conducted as a part of this research indicate the same, that there is not much focus on systematically dealing with environmental matters. Companies were however different in this regard and some had done more than others in terms of environmental work. Only one large company claimed to integrate CP in its operations, and had issued an environmental policy. If companies were concerned at all, then waste water was the issue they were mostly aware of in terms of need for improvement. (Interviews in companies, 2003)

According to experts who have been involved in CP work in companies, there has not been much discussion about CP in industries or in general. Many companies are furthermore not particularly familiar with the concept or underlying strategies, especially the smaller companies. (Yngvadóttir, 2003; Bjarnadóttir, 2003 [Personal interviews])

Of the eight interviewees in companies, five had not been introduced to, or heard about the CP concept before. Three of these were small (8-12 employees) and two were medium-sized or large (50+). Two claimed they had

heard about or were familiar with the concept and one said he had heard about it before, but mentioned though that it could need some revisions. (Interviews in companies, 2003)

None of the companies interviewed had implemented a full CP assessment, but few had conducted assessments on environmental aspects of the process specifically to cut costs, in particular regarding water. The main driver in these cases was thus financial. Regarding the attitude towards systematically implementing Cleaner Production, the answers were not that clear. For most of the interviewees, environmental considerations as such had not been a considerable issue, and therefore not given specific thought. Environmental objectives were thus in general not high on their agenda. It was apparent however, that the larger companies were more aware of general debate about environmental issues, in particular regarding waste water, and what is going on in other countries for example. As a manager in a large company mentioned:

The reason why we don't do more than we do is probably that the pressure has not been that high.. // ..we know [however] what is the trend in similar industries in other countries, both in Europe and the USA, where demands regarding wastewater are much stricter for example. We can surely expect something similar in the future (Interviews in companies, 2003)

From the interviews, both with experts and companies it could be understood that the larger companies clearly have more capacity to consider these things, regardless of how much they had done regarding Cleaner Production work. In this context it is important to acknowledge that these small companies probably need to be approached in a different way than the bigger ones, regarding CP promotion.

It must be noted however that issues regarding the quality and safety of the products were high on the agenda of all the companies interviewed. Internal quality and safety monitoring is required for all fish processing companies, and customer demand is also strong regarding hygiene and safety of the products. (Interviews in companies, 2003) It is very possible that the quality management covers some environmental consideration as well. While quality management systems do not automatically push improvements in overall environmental performance, it can be considered likely to increase the management capacity of the company, and its capacity to implement preventative strategies, that is if the quality management is carried out in a proper way. Issues such as monitoring raw material efficiency would for example in many cases fall within the quality control (Interviews in companies, 2003).

A manager in a large company mentioned also that companies in the sector might be somewhat sceptical, or close their ears to new methods or practical solutions being promoted. Over the last 15 years or so, different solutions have been promoted, such as total quality management (TQM), quality circles, and others, all of which have been good ideas, but at the same time difficult to follow. Some trends have also been less successful. Owner of smaller company also mentioned that there was generally little interest in "listening to outside experts". (Interviews in companies, 2003) This can thus be to impede the promotion of CP, but also is a reminder not to promote it as an 'ultimate solution', but approach it in a 'down to earth' manner.

Why environmental work is not high on the agenda of most companies can also have the following reasons. In the general discussion about environmental issues in Icelandic society, the debate has not been directed at the environmental performance of companies. Most focus has been on large hydropower projects, and conservation of pristine areas of land. The large heavy industries are mainly aluminium smelters, and this is also where public focus has been to much extent. Other industries have been considered less problematic.

There are also not many issues that have been regarded as big environmental concerns for fish processing companies. Water of good quality is generally available and relatively cheap for example, and wastewater has not been a concern until recently, especially now when municipalities are required to make improvements regarding their sewage issues. It has until now not had an economical significance to consider these things, other than potential loss of material but this is less obvious. (Bjarnadóttir, 2003 [Personal interview])

5.1.2 Quality management - HACCP

It is worth looking more closely at the quality work in the companies. During the interviews it became clear that ensuring the quality of the products, hygiene and safety was very high on the agenda in the companies. Customer demand is high regarding these issues and in their processing permits, the companies are furthermore required to conduct internal monitoring regarding health and safety issues⁷. This work is most often done according to the 'Hazard Analysis Critical Control Points' (HACCP) method. HACCP is promoted by the Directorate of Fisheries as the preferable approach to quality control in food industries (Directorate of fisheries, 2003 [online]).

HACCP is a system for internal monitoring in a company and is mostly focused on ensuring the safety and healthfulness of the production. It can also be used to ensure 'just business practices'. It works to safeguard that dangerous objects, dirt, bacteria or other materials do not find their way into the products, that the products are not spoiled and of generally good quality. Just business practises means that products are correctly weighed, packaging has correct information etc. The HACCP method aims to analyse the risk aspects of the production and decide upon proper measures to control these. It includes finding and analysing possible risk points throughout the production cycle, and deciding upon preventative measures to minimise risks and avoid problems to arise. Systematic monitoring with regular measurements and tests is carried out to ensure that health risks are being minimised. Registration of work practices and how the monitoring is implemented is also a very important aspect of the system. (Directorate of fisheries, 2003 [online]).

The method is thus based on a preventative approach to problem solving and involves systematic monitoring and registration. It is thus carried out in a similar way as Cleaner Production. The difference between the HACCP system and Cleaner Production is thus mostly associated with the objectives, meaning that CP aims to minimise wastes and environmental risks from all sources, while HACCP focuses on minimising health and safety risks regarding the products.

While the quality control does not automatically include preventative measures regarding waste minimisation and overall efficiency improvements, it is clearly a very important focus point for most companies, and can be expected to cover some environmental concerns in the companies, such as raw material efficiency. If implemented properly, the HACCP, as other quality improvement systems, can furthermore be assumed to provide a framework for preventative approach to problem solving in the companies. If implemented in a systematic manner, it can also be assumed to increase the management capacity in the company, assignment of responsibilities and flow of information.

Having said this, it should also be noted that some of the companies interviewed, particularly the smaller ones, talked of the internal quality monitoring more as an encumbrance; that is a requirement that they had to fulfil, and related it also to frequent inspections involving costs and so on. (Interviews in companies, 2003) It is thus possible that the potential of the quality systems is not always fully exploited. An expert at the Icelandic fisheries laboratories (IFL) mentioned for example that very few, if any fish processing companies, had a fully computerised quality management system. The information gathered through monitoring might also in most cases not be used systematically for making improvements in the company, but ended up in the shelves. Furthermore that most companies did not have the people and time to consider new things, and new information took long time to have effect in many cases, particularly in SMEs. (Pálsson, 2003 [Personal interview])

⁷ Regulation no.558, 18.09.1997; regarding internal monitoring of the production of fish products.

5.1.3 Concluding the internal factors

The following points are of particular interest in terms of internal factors and the promotion of CP:

- Systematic environmental work is generally not high on the agenda of fish processing companies. Furthermore many companies, in particular smaller companies, are not familiar with the CP concept and the benefits of adopting it in a systematic way. They may furthermore lack the capacity to introduce such systematic environmental work, in terms of time and people for example.
- Some environmental work can be expected to be conducted within quality improvement programs. They are however not focused on waste minimisation and overall efficiency. The widespread use of quality systems does however provide a good opportunity to facilitate the adoption of CP strategies; the method is similar and is based on preventative approach.

The study was only able to touch upon few of the internal factors relevant in terms of CP promotion. Other factors that should be given more consideration are for example: The ability to finance change in the company, technical know how, management capacity and commitment, monitoring and allocation of costs, and the role of individuals in the companies to drive change (Champions). (Rodhe, 2003 [Personal communication])

5.2 *External factors influencing the adoption of Cleaner Production*

Figure 4 presents a model of general external factors that can influence the adoption of CP in a company, based on general CP promotion in industry. The aim of the following sections is to analyse to what extent, and how these factors apply to the Icelandic fish processing industry. That is if, and how these factors function to promote or encourage the adoption of Cleaner Production in companies.

5.3 *Role of Authorities*

Authorities, both on national and local levels, can influence the promotion of Cleaner Production in various ways, and have a role in supporting the spread of CP practises in industries, as a part of sustainable development. Authorities can provide information on CP work, and support CP related initiatives in society. Authorities are furthermore responsible for making the legal and regulatory framework which companies operate in, and can in that way influence the companies directly through legislation. Legislation is reflected upon the companies through operating permits. Authorities thus have several means to influence the adoption of CP in industries. The aim of the section is to briefly discuss some CP related initiatives taken by authorities on national and local level, and how these may influence CP promotion in the fish processing sector, or in general.

It is important to clarify which are the relevant authority actors in this respect. On the national level, it is the ministries and related institutions; and on the local level regional environmental authorities. The relevant ministries are the Ministry of Fisheries, the ministry for the environment, the ministry of finance and the ministry of industry and commerce. The role of the Ministry of Fisheries is mainly to ensure responsible use of fish stocks, ensuring favourable working environment and to generally facilitate the development of the fish industry, for example by providing financial support, providing information and through legislation. The Ministry for the Environment has the role to strengthen and enforce environmental protection in general, and contribute to increased environmental awareness. This is mainly through environmental legislation, and by providing information for companies and the public. Ministry of finance also influences the financial or economic environment of the companies, for example through taxation. Ministry of industries and commerce supports the development of industries, among other. Several institutions work under the auspices of the ministries to carry out more specific roles, and will be discussed later. These ministries have the possibility to influence the performance of companies, and their CP efforts. The following section will however mainly discuss efforts related to the Ministry for the Environment and the Ministry of Fisheries, since these are the most relevant in this respect.

The main tool to directly influence companies is through operating permits. Here it is important to distinguish between national and local authorities. Next section will clarify the role of different actors in terms of issuing permits for fish processing companies, and discuss the relevance of permits in terms of CP promotion. The following sections then discuss other authority related initiatives that could influence CP promotion in the sector or in general.

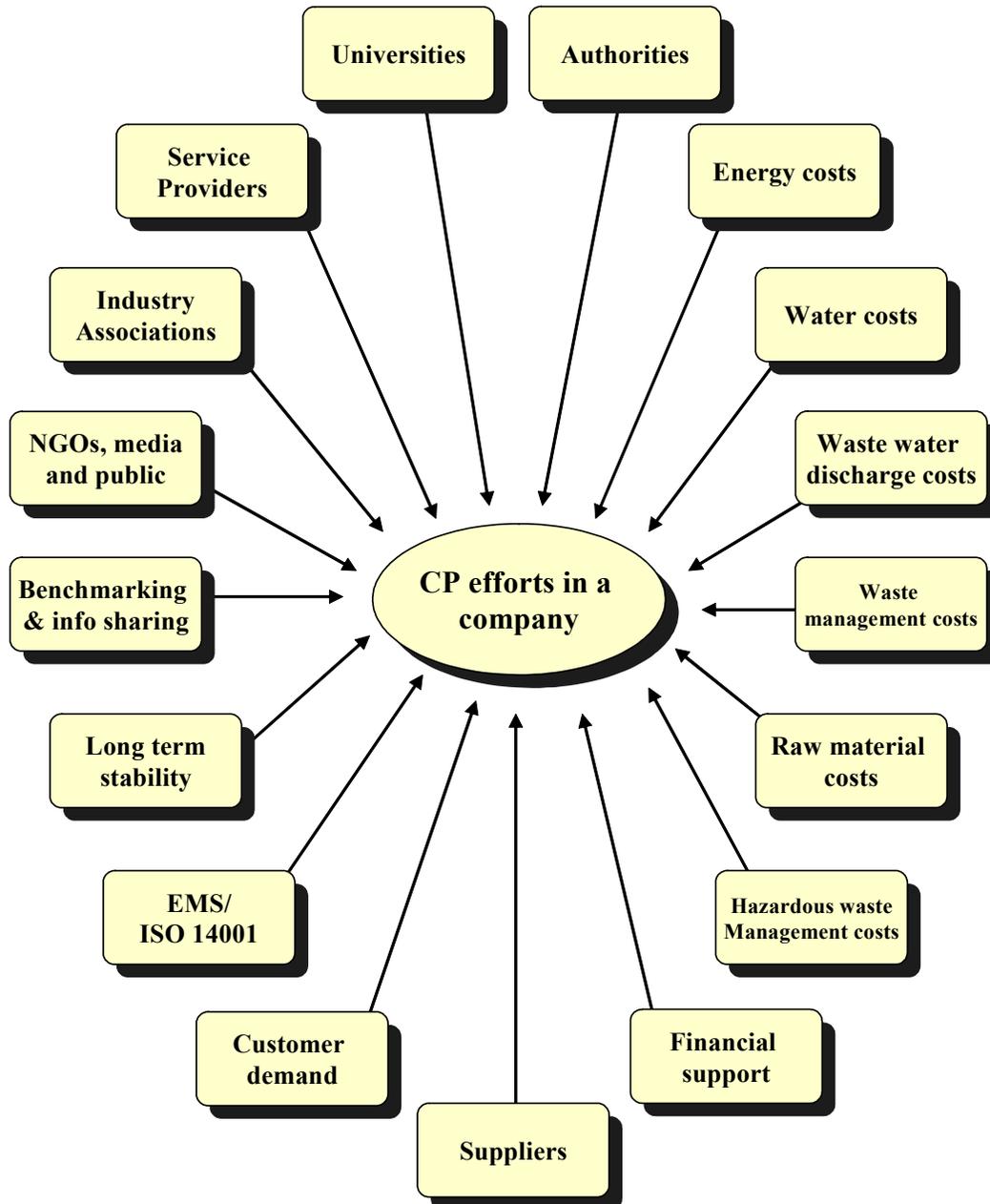


Figure 4. General model of external factors influencing CP efforts in a company (Rodhe, 2003, [personal communication])

5.3.1 Operating permits

Permits are the main tool to regulate companies and are therefore important in terms of the promotion of CP. Permits can influence the adoption of CP promotion either by providing incentives or disincentives for CP adoption; that is either positively or negatively. In this respect it is also important to distinguish between two aspects of the permitting process: 1) issuing of the permits, and setting limits; and: 2) inspections and enforcement of the permits; all of which can be influenced to facilitate the promotion of CP. Traditionally permits have been more focused on pollution control; that is more on demanding specific ‘end of pipe’ measures, than on pollution prevention. Such approach can be regarded as a disincentive for applying preventative measures. Integrating preventative approach in permits thus requires that disincentives being removed and CP incentives added. CP incentives which can be used in permits include for example: the use of inspectors to promote CP, requiring companies to develop CP plans regarding wastes and use of materials, and by setting limits on total pollutants and thus allowing companies to achieve the most efficient solution to reach the limits (Research Triangle Institute [online]).

All enterprises handling with the processing of fish products in Iceland are required to have operating permits issued by relevant authorities. In general the rule applies that all fish processing companies need permits as apply for “industry that is potentially polluting” issued by local environmental authorities⁸, with the exception of fish meal and fish oil processing, which require permits from The Environmental and Food Agency of Iceland. The Agency operates under the auspices of the Ministry for the Environment. Inspections and enforcement are carried out by the respective authorities.

Furthermore all *exporting* fish processing companies require processing licences from the Directorate of Fisheries, which operates under the auspices of the Ministry of Fisheries. These licences are issued by the Quality management department, which is “responsible for the Directorates function as the Competent Authority (CA) as regards the handling, processing and distribution of marine products”. (Directorate of fisheries, 2003 [online]) These are to ensure that basic requirements regarding the *hygienic* conditions of the processing and *safety* of the products are being met. The directorate of fisheries does therefore not have a direct role regarding the performance of the companies as reflected in how they deal with environmental issues, such as effluent issues for example, but primarily with hygiene and quality and safety of products for export. In some cases there is however some overlap of responsibilities. (Karlisdóttir, 2003 [Personal interview]) All fish processing companies are required by regulation to carry out internal monitoring to ensure that demand for safety and hygiene is met and the use of HACCP (Hazard Critical Control Points) system is widespread. HACCP is comparable with other quality management systems such as the ISO 9000 and Total Quality Management (TQM). (Directorate of fisheries, 2003 [online]) Health and safety inspections in the companies are carried out by private inspection bodies, which have an operating permit from the directorate. The Quality management department makes sure that inspection bodies operate in accordance with regulations, and publishes inspection manuals to harmonize the work of inspectors. (Directorate of fisheries, 2003 [online]; Sverrisson (2003), [personal interview])

It was clear from the interviews in companies, that of these two permitting interventions, the one associated with hygiene and safety was substantially higher on the agenda in the companies. Inspections related to the processing licences (directorate of fisheries) are more frequent in the companies, up to four times a year. Companies are furthermore required to carry out internal monitoring, measuring and taking samples etc. as a part of the HACCP system. This is coupled with high quality demand from customers, who in some cases also send their own inspectors to the companies. (Interviews in companies, 2003)

In terms of operational permits issued by local or regional authorities, there is increased tendency in the Reykjavik area to set limits on effluent discharges, and then let the companies themselves find ways to fulfil

⁸ There are 10 districts in the country for local health and pollution control.

these demands. In other areas there is more demand regarding specific pollution control devices. (Karlisdóttir, 2003 [Personal e-mail]) Flexibility in operating permits is often regarded positive in terms of CP promotion since it allows the company to reach a more efficient solution, as compared to when special treatment equipment is required. While the company could still decide to go for end-of-pipe solution, the disincentive for CP is at least removed. (Research Triangle Institute [online])

An interview with one large company revealed that such flexibility had been successful. Instead of the municipality directly requiring end of pipe filtering of the waste water, the facility was able to remove more of the organic material earlier in the process, to reach the goals. (Interviews in companies, 2003)

Pollution permits issued by local authorities do however not to require companies to put forward environmental policies, or to develop CP or pollution prevention plans. (Guðmundsson, 2003 [Personal interview]) Requiring companies to make CP plans makes them go through their use of materials and amounts emitted, and can provide an incentive for companies to keep CP on their agenda. (Research Triangle Institute [online])

A regulation on green accounting⁹ might be one of the most important steps taken so far in terms of putting environmental concerns on the agenda of companies. This is however mostly focused on the large companies and furthermore does not apply to fish processing companies other than fish meal factories with production capacity more than 400 tonnes per day. The law on green accounting became active on 1st January 2003. It requires certain companies to keep accounting over the use of all materials and generation of wastes, and report this information to environmental authorities annually. First date of reporting is the 1st January 2004. (Reglugerðasafn, 2003). Requiring green accounting must be regarded a very positive step. It can be expected to increase internal monitoring in the companies, and will provide information on flows of material and waste generation, and thus provide a benchmark for the enterprises themselves and other stakeholders.

The inspection and follow up process provides an interesting communication channel to companies and possibility to promote CP in the inspection process. While many of the companies interviewed felt they were subjects of excessive inspection, referring mainly to the health and quality inspections, some of them actually mentioned that it might be good to receive information from the inspectors regarding 'good solutions'; for example about CP. This refers mainly to the health and quality inspectors. (Interviews in companies, 2003) There are however some restrictions to how much information inspectors are allowed to provide. In general it applies that they are only allowed to inspect, but not to point to a specific solution.

The Inspection process does nevertheless provide an interesting communication channel; in particular it seems in terms of the health and quality inspections. In those cases the inspectors are from private companies and often seem to have more trust in the inspected companies, they know each other, and the inspectors are familiar with and often with background in fish industry. (Interviews in companies, 2003) Using inspectors for CP promotion may be particularly interesting in terms of reaching the smaller companies which have less capacity to seek information outside the company.

5.3.2 National authorities, sustainable development and the International Declaration on Cleaner Production

Environmental authorities

Iceland has published a national strategy for sustainable development, named 'Welfare for the future – Iceland's national strategy for sustainable development 2002-2020'. There, authorities acknowledge the need to involve companies and industries in the quest for sustainable development, among other things. (Ministry for the environment, 2002) In a project plan for the ministry of the environment 1999-2003, the need for more environmentally responsible behaviour, both from individuals and companies is also mentioned. Companies are

⁹ Regulation on Green accounting no. 851 / 2002.

furthermore encouraged to adopt environmental management. It says: “Environmental management is a way for companies to control and reduce the generation of wastes and conduces towards more efficiency and more profitable business. The ministry will in cooperation with businesses and municipalities exert itself for an educational effort in this field and encourage companies to issue environmental policies.” It is furthermore stated that the ministry will exert itself to encourage waste minimisation, reuse and recycling among general public, municipalities and companies. (Ministry for the environment Iceland, 1999)

The study found however no information regarding a special educational effort, or information material in the field of environmental management or Cleaner Production in companies. Some initiatives in this field have however been conducted through national local agenda 21 efforts, which are supported by the ministry, and is mentioned in the next section.

In 2001, Icelandic national authorities signed the UNEP International Declaration on Cleaner Production. Other Icelandic actors which signed the declaration at the same time are: The national association of municipal authorities in Iceland, Confederation of Icelandic Employers, Iceland Aluminium Co. Ltd., Icelandic Alloys Ltd. and Nordic Aluminum Iceland.

Through the *International Declaration on Cleaner Production (IDCP)*, the United Nations environmental program (UNEP) strives to gain commitment from all stakeholders, to have a role to play in the wider promotion of sustainable production and consumption patterns. The main stakeholders mentioned are governments, companies, industry associations and academia. The declaration is a voluntary statement of commitment to the promotion and practice of Cleaner Production, and is monitored and coordinated by UNEP in its implementation. UNEP has furthermore issued ‘implementation guidelines’ with the main aim to move signatories ‘from signature to action’. (UNEP, 2003 [online])

According to a representative from the ministry, there has not been any specific follow up after signing the declaration, neither from authorities nor from the confederation of employers, as far as he knows. The declaration was signed together with the main heavy industries in Iceland, and what has been done has been mostly focused on these industries, regarding cleaner technologies for example. The green accounting regulation can however also be regarded as an important step towards Cleaner Production. It was however mentioned that the declaration should maybe be given more significance, and put into a more determined pathway within the ministry. (Ólafsson, Hugi, 2003 [Personal interview])

The ministry, and the Food and Environment Agency, which operates under the direction of the ministry, are however very busy with issues directly related to legislative processes. It is therefore possible that if CP promotion does not have a proper place in the system, it is because it has not got a direct relation to legislation. Over the last decade much has changed regarding environmental law and regulation in Iceland. This is mostly related to Iceland’s European Economic Area (EEA) membership, and around 40% of the directives that have come through are regarding environmental issues. This means that there may often be less capacity to deal with other issues. (Ólafsson, 2003 [Personal interview])

In 2001, the ministry signed an agreement to support the development of an environmental management system for small and medium sized enterprises (SMEs) on the internet, in cooperation with the Technological institute of Iceland and Landmat, Software Company. The confederation of Icelandic employers has also been a participant in that cooperation. (Ministry for the environment Iceland, 2003). This is an interesting initiative and is still being developed. There is however need for more funding, to facilitate and accelerate the process, which has been rather slow (Jónsdóttir [1], 2003 [e-mail]).

Economical incentives have been used for the collection and disposal of hazardous wastes, and for the collection of ‘drink cans and bottles’. No charge is levied on industrial waste water discharges.

Ministry of Fisheries

In the environmental policy of the Ministry of Fisheries it is stated regarding the processing of catch that “regulation regarding fish processing should always strive to ensure the healthfulness of the catch and products all the way to the consumer. Use of best available technologies should be promoted in terms of the processing and the environment, and strive for utilisation of all raw material” (Ministry of Fisheries Iceland, 2003 [online]).

The Ministry of Fisheries has initiated a five year effort to increase the value of fish catch, as mentioned in the background section. In order to support the effort a research fund has been established to support R&D, referring to innovation associated with new technologies, better quality and safety of the products, new by-products, more productivity and environmentally friendly and sustainable production, to mention some. The overall aim is to strengthen the competitiveness of the fish industry. The role of the fund is to motivate and support the work of various actors in this field. (AVS rannsóknasjóður, 2003 [online]) It thus provides a framework for action and financial support for supporting development in the fish industry.

It seems clear that the goals of this effort have much in common with CP, and furthermore has financial capacity to put ideas into action. It will thus be argued here that promoting systematic adoption of Cleaner Production practices in companies can strongly support the goals of this effort. Cleaner Production provides a tool to systematically increase overall efficiency in the process, thus reducing costs, and furthermore improves environmental performance and encourages innovation and new solutions. A dynamic and innovative working environment in the sector also provides a good opportunity to include CP. Environmental criteria can for example more easily be incorporated when new work methods and solutions are being introduced. Promotion of CP, and the effort mentioned here, can therefore support each other.

To summarise; there seems to be no lack of interest, and good intentions to further the environmental awareness and work in companies. However it must be said that national authorities could do more to promote the adoption of CP; in particular in terms of providing information about Cleaner Production, and the benefits of systematic environmental work. In terms of permits and regulation, a very positive, and what seems to be the most important step so far, is the regulation on green accounting. As for now, it does however leave out most of the smaller companies, and all fish processing companies other than the larger fish meal and oil manufacturers. Making a strategy for the implementation of the International Declaration for Cleaner Production would be a very positive step. Such work could also entail the wider integration of CP promotion in projects aimed at industries. The five year effort to increase the value of catch is one such project. The goals of the effort have much in common with CP, and systematic environmental work would support the goals of the effort towards increased competitiveness of the fish processing industry.

5.3.3 Local authorities and Agenda 21

Local authorities have a big role in promoting sustainable development, and can have significant influence on companies in their decision to adopt Cleaner Production strategies. Local authorities furthermore have a direct interest in the economic and social development of the region, and in the state of the environment. (Meima, 1997) Companies can be targeted though involvements in Local agenda 21 work for example, but are also directly influenced through operational permits issued by local environmental authorities.

There are many reasons for municipalities to promote Cleaner Production. CP provides an alternative to the ‘municipal end-of-pipe solution’, such as dumping sites and sewage treatment facilities. (Meima, 1997). As mentioned earlier most municipalities either have invested in, or are facing costly constructions of increased wastewater facilities. The intention was that by 2005 all municipalities would have proper sewage facilities, including primary treatment where the receptor is less sensitive, as is most often the case where sewage is released into the sea. This goal will however not be reached before 2016 as it is proceeding now. The cost of constructions falls 80% on municipalities and 20% is covered by the state, in most cases. Waste water treatment has already been installed for the capital area but a majority of other municipalities have not started planning and

preparations regarding their sewage water, largely because of excessive costs. Many of these are municipalities where fish processing is an important industry. In most cases it is however assumed that fish and other food processing clean their own waste water before it is released into the ocean or into the municipal sewage system. (Fráveitunefnd Umhverfissráðuneytisins, 2003) This must be understood in such a way that costs of waste water treatment can be expected to increase substantially in the coming years, both for municipalities and industries.

Local Agenda 21 (LA21) is a strategy to implement sustainable development, which was endorsed at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro. The Association of Local Authorities in Iceland, in cooperation with the ministry for the environment oversees and assists municipalities in adopting LA21. Presently, around 50 municipalities in Iceland, with ~90% of the population, have either adopted or are in the process of preparing Agenda 21. 32 municipalities have also signed a declaration where they commit themselves to contribute to sustainable development, by integrating the goals of sustainability in their actions, and by mobilising the public, NGOs and companies to participate in the LA21 work. The city of Reykjavik is furthermore a signatory of the Charter of European Cities and Towns towards Sustainability - The Álborg Charter. (Samband Íslenskra Sveitarfélaga, 2003 [online]).

There has however been generally little involvement from companies in LA21 work. In 2000-2001 there were for example organised promotional meetings about CP, in municipalities around the country. The interest was however less than hoped for, only on average 11 people came to each of 10 meetings. The intention was also that these meetings would lead to courses about CP at the Technological institution of Iceland (Icetek), but it was not possible to get a minimal number of participants. It is mentioned that even though the initiative can be considered positive in terms of increasing familiarity of CP, it has probably not led to any significant changes in the companies. (Gíslason, 2003 [e-mail][2])

In 2000, the Icelandic Local agenda 21 together with representatives from other actors¹⁰, summoned a meeting to discuss companies and environmental issues. Around 40 people from various sectors of the economy attended the meeting. Its main aim was to discuss which issues were most urgent regarding the companies and the environment, and the role of different stakeholders (businesses and industries, authorities, consultancies, educational institutions, research institutions, media etc.) in that respect. The intention was that the meeting would be to draw the lines for future work in this field, leading to better performance of companies, both environmentally and economically. (Gíslason, 2003 [e-mail][1])

There has however been little or no continuation of what was started at this meeting, it has more or less faded out. It seems as if the responsibility of following up on such activities often falls with people who are already busy with other jobs, and thus cannot devote all their efforts into sustaining what has been started. This has probably been the case here, and it would be positive if there was an actor with the responsibility to coordinate such work, and keep it going (Gíslason, 2003 [e-mail][2]).

It can thus be expected that waste water issues will rise on the agenda in the coming years due to increased costs for municipalities. Promoting preventative strategies based on Cleaner Production is therefore sensible in order to reduce the amount of wastes released, and reduce the need for, and cost of end-of-pipe treatment. The promotional efforts mentioned here have however not been that successful. While spreading information about CP must be considered very positive, and necessary, it may be that stronger incentives are needed to trigger widespread adoption. There also seem to be difficulties with sustaining efforts aiming for further promotion of environmental work in companies. One reason can be that there is no actor that has the responsibility to coordinate such work in the long run.

¹⁰ These were representatives from the Icelandic fisheries laboratories, the Technology institution of Iceland, Línuhönnun consultancy firm, VSÓ consultancy firm and UMÍS ehf. consultancy firm.

5.4 Long term stability

Long term planning is a prerequisite for efficient CP work. Having a long term vision for improvements is essential and furthermore influences the willingness to make CP investments in a company. Long-term stability within the sector can influence long-term planning in companies. If the operational environment is unstable in some regard, companies may for example be reluctant to make investments that don't have short payback times. It can also be expected that a very tumultuous and unstable environment demand a lot of time and effort, which could otherwise be focused on something else, such as Cleaner Production work for example. Instability can thus be expected to be a barrier for CP adoption.

As mentioned briefly in the background section, the fish industry has undergone substantial changes in the last decades, both technologically and in terms of the operational environment in general. Quota issues have been a matter of debate in the whole society, changes in and movement of quotas between regions have in some cases seriously recoiled upon fish processing factories in certain areas. The main instability is thus related to the access to raw material. Quotas also fluctuate between years. All this can make the future of a company more unpredictable, and more difficult to manage. (Ministry of Fisheries Iceland, 2001 [2])

It is thus possible that somewhat unpredictable working environment could impede the adoption of CP. The words of a production manager in a fish processing factory in Reykjavik indicate this:

... I believe that those who have been promoting this [Cleaner Production] must have the story to tell, that there is very limited interest in it...and I am not saying that they have failed, there are many other possible explanations,.. I think it is a good method, not a question about it,.. but if one looks over the history of the last 10 years one can see that there has been a lot going on in the industry, and those that have been leading these companies have simply been very busy dealing with other things.. for example quota issues, and struggling to be the right man in the right place to survive, many even have had to quit. (Svavarsson, 2003 [Personal interview])

Some of the interviewees in the companies also mentioned this, that much of the planning in the company was more on a short-term basis. In particular it has been the supply of raw material that has been unstable at times. It was however mentioned also, that the building of good customer relations and 'goodwill' was indeed a long term process and demanded a long term vision, regarding product quality and safety most importantly. Other factors can also add to the operational instability, such as currency fluctuations. Most companies are exporting companies, and fluctuations in the Icelandic currency in the last years have in many cases been shown to influence the profits of exporting companies. (Interviews in companies, 2003)

The distribution of quotas can also be relevant. Quotas are transferable, and municipalities facing increased costs of wastewater treatment may be reluctant to invest, knowing that the problem could be only temporary. Meaning that if quotas were sold from the area, the basis for fish processing could be substantially reduced or even disappear. It must be assumed that if the responsibility for the wastewater treatment is increasingly given to the companies, the same concern goes for them. If substantial investments were required for Cleaner Production work, and which might not have a short-term payback, instability will most likely make such investment less feasible.

It can thus be said that what seem to be rather unstable, or at least unpredictable operational conditions for many companies, may well be an important factor in terms of the promotion of Cleaner Production in the sector.

The discussion regarding waste water seems however to be largely focused on end-of-pipe treatment of the waste, and the role of authorities in sewage treatment. While this approach can probably not be entirely avoided, more consideration should be given to preventative strategies to reduce the problem at source. This could reduce the overall cost of end-of-pipe treatment.

5.5 *Benchmarking and information sharing*

Benchmarking has been defined as “a systematic process comparing the activities and work processes of an organisation or department with those of outstanding organisations or departments with the aim of identifying ways to improve performance.” (Economist.com, 2003 [online])

Benchmarking is a very important part of the Cleaner Production process. (Rohde, 2000) It is especially useful to assess the real improvement potential in a company by comparing it to best practises in external organisations, for example in terms of the consumption of material or energy in the process. It is essentially the process of learning what other organisations do, to reach the maximum level of performance. It usually involves the comparison of functions and processes with best practitioners, identifying caps in performance and seeking new approaches to bring about improvements in the performance. It should furthermore be carried out continuously and in an open and honest way. (The Public Sector Benchmarking Service (PSBS), 2003 [online]).

The federation of fish processing factories in Iceland runs a program where companies have the opportunity to compare their operational performance to the performance of other companies. The federation offers its member companies to send in information regarding around 20 key operational indicators on a monthly basis. These are however mostly related to factors such as raw material prices, salaries etc. and do not include indicators related to CP or the environmental performance of the companies. The federation makes the relevant calculations and sends it back to the respective company, which can then see where it stands compared to average and maximum values in other companies (anonymously). All key numbers are presented per tonne of raw material. According to a representative of the federation, companies have been rather interested in this initiative. There are however sub-sectors which have been less interested, possibly due to less trust between companies, which correlates with rather difficult operational conditions in those sectors in the last years. The idea with this benchmarking is that companies can improve by seeing where they stand compared to others. The information is however anonymous, and if companies want to contact those that are doing best, they have to do so through the federation. There has however been very little interest in that as far as he knows: “It seems like the companies in general are not quite at that stage yet to share information and to open themselves in that sense. There are only a few companies in particular regions that have been involved in such information sharing”. (Bergsveinsson, 2003 [Personal interview])

According to an expert at the Icelandic Fisheries Laboratories (IFL), who was involved in the previously mentioned CP demonstration project in the fish processing companies, there was substantial interest among the companies to know how others were doing, in terms of material use for example and in particular regarding water use. Companies have nevertheless not done much of sharing their experiences. In her view it would be very beneficial for the dissemination of CP, if companies that have been successful in implementing CP would talk about it, and present their work to other companies. (Yngvadóttir, 2003 [Personal interview])

In an independent exposition made for the Ministry of Fisheries, it says: “The location of many companies in areas with low population increases the need for change of views and information regarding the performance of the companies. Little change of information has for long been prevalent in the fish industry, but a comparison between ones own performance and the performance of others is essential for one to know where to proceed.” (Matcon, 1997)

The company interviews support what seems to be little sharing of information between firms. This was particularly apparent among the smaller companies visited. *How* they do things seems not to be discussed between companies, as an owner of a small fish processing company put it when asked about communication between companies:

Yes we try to follow what others are doing, but people want to keep their privacy also, be a bit closed off, not everybody can enter here. We have often talked about putting black films on the windows [into the

processing area]. There are many [fish processors] that come here and go straight for the windows, .. so there is not much interconnection between companies. Perhaps some groups that chat about what is bought on the market and so on, but people try to keep their own things private, nothing talked about how we do the things, maybe what ... but never how. (Owner of a small (10-12 employees) fish processing company)

This company owner had earlier described how he was able to reduce the water costs by 50% by introducing simple housekeeping changes. What initiated that work were high water costs for the company. Related to that he had discussed in the media what he perceived as high water prices compared to other municipalities. This resulted in many companies contacting him and asking about the prices and so on, people even talked about drilling their own water hole. According to him, this was the only communication with other fish processing companies regarding something that can be considered CP related. In this case there was however no share of information on how the company managed to reduce its water use; and none of those interested in the water prices asked. (Interviews in companies, 2003)

The study was not able to find any information about CP benchmarking activities among companies; the examples above also indicate that the use of benchmarking and information sharing in general is quite limited. Companies seem to be interested in what is going on in other companies, but at the same time not quite ready to cooperate or share information to improve performance. Benchmarking is an essential tool in any CP process, to be able to see the improvement potential in the company and to learn from others. More CP benchmarking could thus facilitate more successful CP activities. Industry associations for example, could further encourage and promote the benefits of such cooperation, both in general and in terms of CP, through their already existing initiatives.

5.6 Service providers - Research institutions and others

Most of the Cleaner Production related work undertaken in Iceland, has been initiated and organised by industry research institutions, the Technology Institution of Iceland (Icetek) and the Icelandic Fisheries Laboratories (IFL). These projects have already been mentioned in chapter 4.

The Icelandic fisheries laboratories (IFL) are a research and service- institution serving the fish industry, other food industry and related sectors. Their role is to do research, implement measurements and tests, consult and communicate information related to its work. This work includes the utilisation and processing of material in fish and food processing, to ensure efficient use and sustainable utilisation of resources. The institution cooperates with universities, other institution and companies. (The Icelandic fisheries laboratories, 2003 [Online])

The *Technology Institution of Iceland (IceTech)* is responsible for various research and development projects and provides Icelandic industries with various industry specific information and services. A department of environmental technologies provides companies with various services regarding environmental work in companies among other things, such as Life cycle assessments, environmental management systems and Cleaner Production, among others. The department, in cooperation with other actors has developed and published various information and tools for aiding companies in their Cleaner Production work. This includes a "Handbook for Cleaner Production", which was developed based on experiences in the CP demonstration projects. A tool has been developed for an easy environmental (CP) assessment in companies, specifically designed for Small and medium sized enterprises (SMEs), and software for green accounting in companies, among others. The department also runs courses on demand, about environmental work in companies, including Cleaner Production. According to information from Icetek, there has been generally limited interest in these initiatives from companies, most interest has been in the green accounting tools, which is related to many companies being required in regulation to do green accounting (Jónsdóttir [2], 2003, November 19 [e-mail])

Both of these institutions are run partly on public funds, but also rely to a large extent on privately funded projects. Their work is mostly project orientated, that is research and development projects have a defined

budget and duration. This has some implementations in terms of the CP work initiated and supervised by these institutions.

According to an expert participating in the CP demonstration projects at the Icelandic fisheries laboratories, there was substantial interest of their behalf to continue this work in some form to push for a wider dissemination of the CP method. For example with CP projects in different fish processing enterprises. It was however difficult to renew funding for such work. Follow-up and promotion is furthermore quite difficult for them. Their role is more to test new methods and demonstrate how they work. Then it is others to take it from there, such as private service providers. They don't have the means for continuous promotion after the (demonstration) projects end. What they were able to do was to organise courses and information material for Cleaner Production work in companies. There was however very little interest in the CP courses. What they could do in terms of follow up and promotion of the CP method was therefore not very successful due to the circumstances. In her opinion they did what they could. At the same time it is disappointing to have a method that works and has been shown to be successful, but is despite that not generally applied in the companies. (Yngvadóttir, 2003 [Personal interview])

The study was not able to gather much information about CP related efforts from the private sector, that is regarding the particular services that they provide or their promotion effort. There are however several consultancy companies that provide both technological and management solutions related to environmental issues in companies, including Cleaner Production.

The study has information about one promotion effort from a private service company, directly aimed at fish processing companies. It involved sending out a newsletter with CP related information and environmental work in general, and then following it up by contacting the companies. There was however very limited interest in that initiative from the companies, and thus little continuation. (Bjarnadóttir, 2003 [Personal interview]) For the private service providers in general there seems not to be much to do other than participating in the discussion and provide information, and as most people interested in these issues have done, to find themselves something else as their main focus, until the companies themselves feel the need to take these issues on their agenda. What authorities can do is to provide the framework, but the companies have to act themselves. (Jónsson, Guðjón [e-mail])

A report about the operational environment of Icelandic SMEs by Aflavaki (1999), mentions that small and medium sized companies do rarely seek support outside the companies, such as consultancy services and other service organisation. Very few SMEs had used consultancy services and mentioned high cost as the main barrier. The smaller the company the less they use the services. They are also rarely familiar with which services are available from the various support actors such as research institutions and industry associations. Only 20% of companies had used services provided by these. Most SMEs thought that relevant information from these actors was inaccessible. 70% of fish processing companies thought such information was inaccessible. Size is here important since significantly more large companies had used services available to them. In terms of cooperation and relations with other companies the report finds that over 70% of SMEs in the fish industry didn't cooperate with other companies, such as on research and development, and didn't intend to do so in the next 12 months. (Aflavaki, 1999)

Interviews with the smaller fish processing companies indicated the same. They claimed usually always to solve issues within the company instead of seeking consultancies. The external services sought were mostly related to maintenance of equipment for example. The main barrier for using consultancies was the cost, but also lack of time to monitor which services were available to them. (Interviews in companies, 2003) The concern is thus that the smaller companies be left out regarding information about CP, since they seem to have less capacity to seek such information, less interest, or both. (Interviews in companies, 2003)

It can be said that most work regarding CP in industries has been carried out within the main industry research institutions. What has been lacking however is to follow up on the positive results of that work, with active promotion of the benefits of systematic environmental work. The research and service providers seem not to have the capacity or for any long term promotion efforts in this regard. The examples above also indicate that smaller companies have less capacity to seek services from outside, and may thus need more support in initiating environmental work.

5.7 Industry associations

The main role of industry associations is to service and to safeguard the interests of its members. There are mainly four associations relevant in the Iceland fish processing context. Two are directly related to the processing industry. The *Federation of Icelandic Fish-processing Plants (SF)* comprises about 100 companies with a man-year total of about 6,000. These companies are responsible for processing approximately 80% of the catch. The federation deals with various issues specific for the sector, and assist companies, for example with interactions with authorities and give advice regarding law and regulatory provisions. (Confederation of Icelandic employers, 2003 [online]) There is another association, which is specifically for fish processing companies that are not affiliated with fish vessel owners. The number of members is significantly less than in the other association and the companies are generally smaller. These companies mostly rely on raw material that is bought on fish markets, since they don't have access to quotas.

Another federation related to the fish industry is the *federation of Icelandic Fishing Vessel Owners (LÍÚ)* with members about 190 fishing companies, and man-years approximately 4,700. They are thus not directly for the fish processors, but in many cases the processing companies are also fishing vessel owners, and thus are members of both associations. (Confederation of Icelandic employers, 2003 [online])

A fourth actor in this respect, is the Confederation of Icelandic Employers (SA), which is an umbrella association for 7 sector associations, including the *federation of fish processing-plants* and the *Federation of Icelandic Fishing Vessel Owners*. The confederation of Icelandic Employers works to ensure a favourable working environment for its members to operate and develop. (Confederation of Icelandic employers, 2003 [online])

The federation of fish processing factories has not been much involved in CP related work, apart from some efforts to agitate for saving water and filtering of fats released from processing plants, around 10 years ago. (Bergsveinsson, 2003 [Personal interview]) There is certain division of responsibilities between the confederation and the sector associations, and environmental issues have been largely the responsibility of the confederation. It is the task of one person, whose role is primarily to work as coordinator between the sector associations, authorities and other relevant actors when it comes to environmental affairs. (Mariusson, 2003 [Personal interview])

Regarding information and education for its members; the confederation does not organise such activities, such as courses or conferences. This is the responsibility of research institutions and other service providers. The confederation and the federation of fish processing factories however claim to encourage their members to seek courses and information from these actors. They furthermore stressed the importance of these actors regarding CP related R&D and providing services. The confederation has however cooperated and supported the development of some tools for environmental work, primarily at the Technology institution of Iceland. (Mariusson, 2003 [Personal interview])

As mentioned in previous chapters, service providers and research institutions have felt little interest in CP related activities, courses and information, from companies. The information and know-how is available but the demand for it is limited. (Bjarnadóttir; Skúladóttir; Jónsdóttir, 2003 [Personal interviews]) Discussions with Mariusson at the confederation of employers (2003 [Personal interview]) revealed that this might be the case;

and that there was not adequate efforts made to promote the benefits of organised CP work. Providing information and tools is thus not enough on its own. The benefits of applying them must be adequately promoted in companies. Mentioned among other things was the role of universities in CP promotion. Cooperation between companies and universities has not been common when it comes to environmental work, but has interesting potentials. Involving students in CP work can benefit both students, the universities and companies, and provides a less expensive alternative for companies to adopt more systematic environmental work. (Mariusson, 2003 [Personal interview])

The confederation of employers is one of the signatories of the international declaration on Cleaner Production. The study did not find any information about particular initiatives to follow up on the signature, from the confederation.

From a company perspective, the smaller companies did not mention any pressure or motivation from their industry association. One of the small companies was furthermore not a member of an industry association. It was furthermore the view that the association would not have capacity to do any such promotion work, due to its small size. The larger companies did talk of some pressure or rather discussion from their industry association, but this was more from the federation of Icelandic Fishing Vessel Owners (LÍÚ), and often regarding environmental conduct of the ships themselves. (Interviews in companies, 2003) This can however be expected to influence the whole operations of the companies, also the processing. A manager in a big processing company mentioned however that discussion about environmental matters seemed to come every few years rather than being continuously on the agenda, and then often related to important international conferences (Interviews in companies, 2003).

There has been cooperation between the confederation and authorities regarding certain environmental issues, one of which is a regulation on hazardous waste levies, and other issues related to companies and the environment. The confederation has also been involved in an initiative to develop an online environmental management system for SMEs, together with the Technological institution of Iceland. As mentioned earlier however, the process seems to be rather slow due to limited funds. By signing the international declaration on CP, the confederation has committed itself to further efforts in this field; and having a strong link to the companies, has a fundamental role in this regard. Commitment is a prerequisite to put ideas into action. Making a plan for the implementation of the International declaration of Cleaner Production would be a very positive step, and give a clear message to their members. Being a strong lobby group they also have the possibility to push for increased role from other actors, such as universities. The benchmarking initiative run by the federation of fish processing factories also offers an interesting ground to facilitate CP, as discussed in section 5.5.

5.8 Universities

The main role of Universities is to educate and train people, and furthermore to gather and systematise information. In building a sustainable future, Universities thus have a profound role in terms of increasing awareness and knowledge, and to develop tools and technologies. Their role in the promotion of Cleaner Production should thus be through training people, research, policy development and information exchange between industry, academia and other stakeholders. (UNEP, 2003 [online])

The main university is the University of Iceland; there are a number of other universities and colleges on university level. Including the University of Akureyri in north of Iceland, and the Icelandic College of Engineering and Technology, among others.

The University of Iceland has an Environmental research institute, which was founded in 1997 through a directive from the Ministry of Education, Science and Culture. Among the main goals of the institute is to coordinate and strengthen environmental research and education in an interdisciplinary manner. The institute oversees a research-orientated master's programme in environmental sciences.

According to Gunnarson (2003 [personal interview]), director of the environmental research institute at the University of Iceland, the university has not done an adequate job in promoting and supporting the dissemination of more organised environmental work in companies. There are for example few or no courses available for those students that want to specialise in environmental management. These students have had to seek this education abroad. The master's programme is a positive step however, since it brings people with new ideas and knowledge into the workforce. There are however several barriers within the university that must be overcome. Certain departments are reluctant to adopt more interdisciplinary approach, and there is for example little integration of environmental focus in business and economy studies, even in courses where these would go together.

The University of Akureyri in Northern Iceland, offers a BSc level programme in environmental studies, within the faculty of natural resource sciences. The programme has some focus on problem solving and as thus rather practical in nature, and more interdisciplinary which is a good sign. (Gunnarsson, 2003 [personal interview]) The university furthermore has strong linkages with fish industry and companies in general.

Regarding cooperation between students and companies regarding CP, there is information about one project where students cooperated with a fish processing company in northern Iceland, to establish environmental management in the company. (Bjarnadóttir, 2003 [Personal interview])

While the study was not able to gather much information on the role of other universities in terms of possible CP related work, it seems that universities and colleges should and could have an increased role in the dissemination of CP in the society. It is also interesting since the confederation of employers, which is the main industry association, appears to be interested in an increased role of universities in terms of environmental work in companies. Cooperation between companies and students in terms of CP and environmental management can provide a cheaper alternative for companies, than to pay for private consultants. Such cooperation would benefit all actors involved. For this to happen, barriers for integration of environmental focus in other disciplines must be overcome. Dedicated interest from the larger industry associations and cooperation might be able to facilitate such change..

The role of universities in promoting CP goes beyond environmental management or studies; CP must be integrated in a range of relevant subjects, such as engineering, technologies and management studies among others. This is an interesting area of further attention; that is the role of universities in environmental education in general, and how CP thinking is integrated in the curriculum.

5.9 Environmental management systems (EMSs)

Environmental management systems (EMSs) are common tools to manage CP work. It is important to clarify what is meant with an EMS in this respect. An EMS can be a system that is set up by the company to systematically organise and systematically deal with its environmental concerns. It can be said that such systematic approach is a prerequisite for CP work. EMSs can however also refer to *certified* systems, such as ISO14001 for example. A certified management system is not necessary for CP work and is not necessarily very helpful. Systematic CP work does however prepare the company for getting a certified system, if it is interested in doing so.

It can be said that EMSs provide a structure, or a tool, for companies to pursue environmental objectives and improve its environmental performance. It however depends on how these objectives are chosen, what the results will be. EMSs do not automatically result in improved environmental performance, but they can do so if the objectives are focused on applying preventative environmental strategies / Cleaner Production. CP also provides a more cost effective approach to environmental management, since it focuses on overall efficiency improvement. (Hamner, 1996)

There are only 3 Icelandic companies that have certified environmental management systems; all of these have ISO 14001. There are no fish industry companies that have adopted such systems, and there is no information about companies in the sector that are in the process of doing so. This alone is quite interesting given the significance of the sector economically, its reliance on natural resources and furthermore that most of its markets are foreign. Some of the larger fish processing companies can furthermore be regarded as quite big, even on an international standard.

Certified EMSs are perhaps more relevant for the larger companies, but the companies interviewed had not seen a reason to adopt such systems so far. While the interviews did usually not discuss environmental management systems much as such, it was clear in many cases that the interviewees associated such systems and environmental management in general with added costs. (Interviews in companies, 2003)

According to a survey made by Eggertsson (2003), the familiarity of environmental management in fish processing companies is limited. The attitudes towards the benefits of environmental management seem to be rather positive however. At the same time half of the respondents were not sure that the overall financial benefits of environmental management would be more than the costs associated with it. The most important barrier for environmental management is perceived as high costs. Interestingly the 4th most important barrier mentioned is the demand for a profitable business, which is related to the perception that cost is the main barrier. The main benefit of environmental management mentioned was to fulfil the demand of customers; the second most important benefit mentioned was to comply with stricter law and regulations, and the third was perceived as better market opportunities.

It seems therefore that environmental management is generally associated with extra costs. If that is the case it must be considered unlikely that EMSs will be an important tool for CP in the fish processing sector, where reducing costs is one of the main concerns. This however also points to the need to educate companies about EMSs and the benefits, and furthermore that when promoting environmental management it should be associated with systematic CP work, to ensure the cost effectiveness and environmental benefits of environmental management. The fact that environmental management is not associated with cost reductions may however not be that surprising. Companies usually believe they are working with high efficiency, and inefficiencies are often hidden, and require systematic measures to be found. The interviews in the companies did for example reveal that in several cases there were aspects that were not properly monitored, or were considered irrelevant, which does not indicate that they are being managed in the most efficient way (Interviews in companies, 2003).

5.10 Customer demand

Supply chain pressure such as demand from customers has often been shown to be a strong driving force for improving environmental performance in companies, even though the overall impact has been modest internationally (Reijnders, 2003). At first glance one would think that pressure regarding environmental work in Icelandic fish processing companies would be considerable, given that many companies export to markets where environmental demand to companies is considered to be higher than in Iceland. Customer demand seems however in general, not to be a significant driver for more organised environmental work in the companies.

In general the company interviews implied limited pressure from customers regarding environmental work; it was nevertheless not uncommon that customers had made some enquiries regarding environmental work in the companies, even though this had in most cases not led to any specific actions. More common however was significant pressure regarding hygiene and safety in the processing of the products. It seems also that the larger companies felt somewhat more pressure than the smaller ones. A manager of a large company mentioned for example that one of their larger customers from Spain had been asking about their waste water issues: "They had seen that processing facilities in France usually treated their waste water and therefore they asked, these issues

may however be more acute there than here, for example regarding the use of water”. (Interviews in companies, 2003)

A survey by Eggertsson (2003) also finds that customers do in very few cases ask for information regarding environmental work in the companies.

Personal communication with a company that had participated in the CP demonstration project revealed that customers are starting to make more demand regarding the company culture in general, and environmental performance is a part of that. It was mentioned however that the customer pressure was mostly regarding the sustainable use of fish stocks, but not the processing as such. (Jónsson [2], 2003 [Telephone interview]) The follow up survey mentioned in section 4.1.1, also revealed that one company that had participated in the program was starting to give more consideration to its environmental work again, not least because of more concern from their customers.

It is worth noting that the large companies are usually both involved in the fishing and the processing of the catch. It was understood that pressure was in general more focused on sustainable harvesting of fish stocks, given that management of fish stocks is problematic and high on the agenda in many of the main market areas, for example in the European Union. (Interviews in companies, 2003) Such pressure could however influence all environmental work in the companies. If that is the case however, then the influence will mostly influence those companies that are directly involved in fisheries as well.

In summary it can be said that customer demand has not been a significant driver for environmental work in companies. It is however possible that such pressure is increasing, at least for those companies that are also directly involved in fisheries. One explanation for limited interest from customers can be that CP efforts in a processing company are not visible in the product per se, and customers are thus less likely to demand such work from the companies. What is more important in terms of demand from customers is that the product is safe and healthy, and this is already an important concern.

5.11 NGOs, media and general public

NGOs, media and public can put pressure on companies to improve their environmental performance. Environmental awareness has been increasing in Iceland over the last decade. There has however been little discussion about companies and systematic environmental work in the society. It is also likely that increased awareness among the public is mostly reflected upon companies through stricter regulation. Much of the environmental regulation also has its origin in Europe and is brought to Iceland through EEA membership; which can then also increase the awareness in Iceland.

In terms of fish processing directly, then it is unlikely that pressure from the public or from media has significant influence in terms of CP. The work of environmental NGOs is furthermore focused on other issues, such as nature conservation. It is likely that fish processing is not considered a real problem, and the issues at hand may deal more with overall efficiency in the process, rather than serious environmental threats. Complaints about smell from fish processing are however not uncommon (Karlisdóttir, 2003 [Personal interview]), and also when pollution control from fish processing plants breaks or is inadequate (Agenda 21 Fjardarbyggd, 2000). The overall CP influence is however most likely modest.

5.12 Suppliers

Suppliers provide industry with chemicals, equipment, raw material etc. and are in that way important in terms of any CP changes in processing operations. In terms of CP work in a company it is also important that suppliers include environmental or CP criteria in their products and services. For fish processing the most important supply is fish; other important supplies include machines and equipment for the processing, soaps and detergents

for cleaning, water and energy. The most important supply is the fish, which is the basis for holding out operations. Machines and equipment are important in terms of how efficiently they make use of materials and energy.

How the fish is handled on board the ships is very important in terms of how efficiently it can be used, and in terms of the value of the final product (Ministry of Fisheries Iceland, 2002; Interviews in companies, 2003). A part of the scope for increased raw material efficiency, and the increased value of the final product, therefore lies beyond the processing facilities and with the fishermen. The smaller companies who buy their products on a market, may be in a more difficult situation to influence their fish suppliers, than those that have their own ships.

The interviews in the companies revealed that the quality of the raw material and the price is their main concern, since this determines the price they get for the final product. This concern was particularly apparent when interviewing the smaller companies, which rely on fish markets. The interviewees were also asked whether they emphasised to purchase environmentally labelled products, for example when it comes to chemicals. None of the companies made such particular requirements. The use of soaps and detergents is however strictly regulated, in terms of the types of chemicals allowed for food processing, and falls within the internal quality control in the companies. The focus is however more on the hygienic and safety aspect, rather than the environmental aspect per se. (Interviews in companies, 2003)

It has also been mentioned that many companies have in the last years increasingly started to have external companies taking care of issues such as cleaning and making cleaning schedules. (Pálsson, 2003 [Personal interview]) A representative from a large company mentioned that by bringing in external experts to take care of their cleaning, the water use had increased to some extent. This increase was mainly because of apparently different cleaning techniques, and use of less water pressure for the cleaning. (Interviews in companies, 2003) It is thus possible that conflicts can arise between CP concerns and hygienic concerns. This also stresses the importance that CP is known by all actors and integrated in the services and products provided by the suppliers, so that CP is emphasised to all extent possible.

Future efforts to increase the value of fish catch can also be expected to influence suppliers, for example in terms of development of new technologies and equipment for the fish processing industry. There have also been educational efforts to improve the handling of the catch on the boats.

5.13 Financial assistance

The study was not able to find any financial assistance that is available to companies in terms of the direct adoption of CP practises. There are however some funds that offer assistance to various projects, and can thus be CP relevant. These are mostly focused on research and development. The two that are most relevant for the fish industry are: The *AVS fund* is under the auspices of the Ministry of Fisheries and provides assistance to research and development that supports the effort to increase the value of fish catch in the next 5 years. This initiative increases the total capital available for development of the fish industry substantially, and is also designed to support practical solutions rather than basic research (Pálsson, 2003 [Personal interview]). Another initiative is cooperation between fish industry and other industries to develop new technologies that can add value in the fish industry. This fund has supported the development of several CP related solutions, in terms of raw material efficiency, waste water handling, and others (Samstarfsvettvangur sjávarútvegs og iðnaðar, 2003 [online]). The Icelandic centre for research also provides support for various researches, among other.

The available support is thus mostly in terms of research and development, and much related to the overall effort to increase the value of fish catch (AVS). The AVS fund is a strong input for developing the sector in the next years, and can serve for CP related projects. The funds could also influence the dissemination of CP, for example by including CP criteria when evaluating applications for financial support.

It is also worth considering if companies would have to be supported financially to adopt CP strategies, for example by offering subsidised CP assessments in companies, or by subsidising CP training, particularly for SMEs. Such support must be expected to give an added incentive for considering CP.

5.14 The role of prices and costs

Prices of inputs and non-product outputs can influence how efficiently resources are being used in a company. The more expensive a resource is, the more incentive there is to use it efficiently or systematically reduce its use. Reijnders (2003) mentions that the attractiveness of Cleaner Production comes to a considerable extent from savings regarding physical inputs. This can therefore have implications regarding how a company perceives the potential benefits of adopting Cleaner Production practices in a systematic manner. In the context of Icelandic fish processing, it is thus of interest to see whether prices or costs of inputs and non-product outputs are likely to provide an incentive for companies to adopt a systematic way to minimise wastes and increase overall efficiency. Prices of inputs such as water and energy, and for non-product outputs is usually substantially lower in Iceland than in countries to which comparisons are often made, such as in Scandinavia. This section is to a large extent based on the company interviews, where the interviewees were asked about the main operating costs and if these had been drivers to systematically increase efficiency.

5.14.1 Raw material costs

Most costs in fish processing companies are associated with raw material; that is fish. In white fish processing, the raw material cost is typically around 65% of total cost in the company. In terms of being efficient, this is therefore their main focus. This is also where companies believe they are doing quite well in most cases. The companies usually take random checks on the raw material efficiency over the day. One company owner in a small company did mention how important it was to systematically monitor and maintain the filleting machines over the day for example. An efficiency difference of only 1% has a lot to say, can be around 22.000 Ikr. per day for the company (~2300 Sek), which is significant for a small company. All cut-offs and solid organic wastes are then sold to other facilities for by-products. The use of waste materials has been increasing over the years, and specialised companies make products of what can be used. (Interviews in companies, 2003)

5.14.2 Water costs

Water costs were not a great concern for most of the companies. Water is relatively cheap, a common price per m³ is around 15-18 Ikr (1.7-1.8 Sek). Most of the companies believed the use of water was as low as possible, and thus did not see a reason for too much effort to reduce it more. Owner of a company in Reykjavik however did complain about excessive use and high prices; this had not lead to any preventive efforts to reduce it though, nor to monitor it more specifically. In another company high costs had pushed the owner to go through the water use in order to reduce it, a few years ago. He managed to reduce costs by almost 50%, only with simple housekeeping solutions and increased measurements. In many cases the companies did not monitor the water use specifically, that is they knew the total use, but not in more detail. The two largest companies did however claim to monitor the water use in more detail, in one case also due to more focus and pressure from local authorities regarding the waste water. (Interviews in companies, 2003)

The water use in many of the small companies in Reykjavik can be around 35-40 tonnes water per tonne raw material, for those processing fresh fish. In the larger companies this is substantially lower, or 18-20 tonnes water per tonne raw material. Apparently the difference lies to some extent in the size of the companies; the less that is produced, relatively more water is needed. (Karlisdóttir, 2003 [Personal interview])

Many municipalities have been increasingly taxing water in the recent years. While this can be seen as a driver for saving it, it has probably not resulted in any specific action, so far at least. Companies do generally not complain about the water costs (Rúnarsson, 2003 [Personal interview]).

5.14.3 Energy costs

Energy can be a substantial cost in fish processing companies. The extent to which this differs however substantially between the types of processing, as is with other inputs; fish meal and oil factories are for example those that are most energy intensive. Freezing of fish is also a potentially energy intensive process.

Energy costs had not been to trigger any specific preventative action in the companies interviewed. These costs were often regarded as fixed, that is not possible to reduce. One of the companies mentioned though that hot water was probably something that could be reduced, in terms of heating the facilities, and had not been properly given attention. Hot water was however not considered expensive; at least they knew about the problem but had not taken action to fix it. (Interviews in companies, 2003)

It should be added also that energy in Iceland generally comes from renewable sources, and energy efficiency is generally not a big issue. If one uses a lot, the costs can be significant nevertheless. For fish meal factories this is however different since they often use oil as a fuel. They thus have a stronger financial incentive for cleaner technologies, and furthermore more pressure from authorities, due to air and smell pollution. This has resulted in measures taken in several companies.

5.14.4 Waste water costs

Fish processing is one of the main sources of waste water in Iceland. The waste water contains in many cases high amounts of organic material, such as fats and proteins.

Companies are not charged for the waste water they release from the processing. Most waste water is furthermore released directly and untreated into the ocean. (OECD, 2001) There is thus no real incentive to reduce the amount of waste water. The two biggest companies interviewed were however more aware of the waste water concern, and one of them had implemented special measures to reduce the amount of organic wastes released in their waste water, mostly due to increased pressure from the authorities, which are concerned over their treatment facilities. The other company had not implemented such measures to deal with the waste water, but was aware that such requirements would probably increase. They had started to look into some measures that could be taken in that regard. It was mentioned that it was not at all unlikely that valuables would be in the material released in the waste water, and could be used. (Interviews in companies, 2003)

Given that the costs of waste water treatment will increase substantially for many municipalities in the next years, this may become a very important factor in terms of CP efforts, in particular if cost will be levied on the water effluents from industry.

5.14.5 Waste management costs

Solid wastes that are generated are mostly organic, and are in most cases sold for making by-products. This is therefore some incentive for raw material efficiency. Other waste management costs seemed to be perceived insignificant for the companies, and thus not drivers for change. (Interviews in companies, 2003)

5.14.6 Hazardous waste management

This is not a significant issue for most companies. There was in general little or no hazardous waste associated with fish processing in the companies interviewed. This cost was thus insignificant, if any. (Interviews in companies, 2003)

5.14.7 Other costs

Cost of packaging for the products was significant for all the companies interviewed. The types of packaging differ between types of products, for example those exporting fresh fish usually use Styrofoam, while frozen fish

is exported in plastic bags and paper boxes. The customer does have most to say regarding the type of packaging they prefer. It was mentioned in the fresh fish processing companies, that there was increased concern over the Styrofoam since it was expensive to dispose of in the respective countries. Note that this is not a direct environmental concern in Iceland, but for the customers that buy and distribute the fish abroad. There is therefore increased concern from customers in some cases to use alternative packaging material. One interviewee said however that they would prefer the Styrofoam, since that would be safer in terms of keeping the fish cold during transport. (Interviews in companies, 2003)

Soap/detergent costs differed in terms of how significant they were perceived. Some of the interviewees had gone through it and cut costs. Another one mentioned that his use of detergents was inadequately managed and not properly monitored, and he would most probably be able to reduce the use, and costs, with simple changes, assigning responsibilities and so on. (Interviews in companies, 2003)

5.14.8 Concluding the costs

With the exception of raw material costs, there are few costs that have been drivers for CP initiatives. Raw material is an important issue, while other factors often receive less attention, particularly in smaller companies. The smaller companies sold their wastes for making by-products. Even though the price is not high, they get rid of the waste without cost. The larger sometimes have their own fish meal factory, or their own by-product processing. Even though generally not a significant concern, water costs have in a few cases driven changes, and pressure from authorities due to waste water had resulted in a company increasing monitoring and measuring of its water use, as well as reducing organic material in the water. In general, companies claim to be working efficiently and minimising costs. (Interviews in companies, 2003) Proper monitoring is however crucial to be able to maximise efficiency. More water also means that more material can be washed away. Furthermore less obvious or perceived as less important inefficiencies, can prevail if they are not targeted in a systematic manner, and if monitoring is not sufficient, as was the case in the soap example in section 5.14.7., and is likely to be with water in many cases.

It has been mentioned that one of the difficulties in convincing Icelandic companies to adopt CP is that the waste handling costs are not significant. In some cases the costs of sorting wastes are higher than the benefits of doing so for example. The potential savings from CP are thus mainly in terms of more efficiency and less generation of wastes, but this is where the companies often have more knowledge and believe they are doing very well, even though experience often shows something else. The first priority is thus usually to look at the energy use, that is electricity and hot water. (Jónsson, 2003 [e-mail])

The previous example shows the difficulties of pointing to prices and costs to trigger interest in CP, in the Icelandic context.

5.15 Concluding discussion about the factors

The chapter has discussed a range of factors which have the potential to influence the adoption of Cleaner Production in companies. The aim was to specify how these factors apply in the context of Icelandic fish processing industry, in order to see how CP promotion could be facilitated. While not complete, a picture has emerged giving a short overview of the main influencing factors, including the role of various actors in that respect.

Regarding the internal factors it has already been concluded that systematic environmental work is generally not high on the agenda of fish processing companies, and that many companies, in particular smaller companies, are not familiar with the CP concept and the benefits of adopting it in a systematic way. Quality work in the companies can however be seen to provide a good opportunity to facilitate the adoption of CP strategies; the method is similar and is based on preventative approach.

Regarding the external influences it seems that in general there is not much pressure, or motivation for companies to adopt CP. With the exception of raw material, prices give limited incentive. There is furthermore substantial scope for most actors to be more committed in promoting CP, give a stronger incentive for companies to adopt CP, and in general facilitate the adoption process. Customer demand regarding systematic environmental work is limited, but may be increasing for the larger companies in particular.

One can now look back and ask which of these internal and external factors discussed above would be interesting in terms of the future promotion of CP in the industry, and then attempt to present a more specific model for the Icelandic fish processing context. The factors discussed above do all have the potential to influence CP efforts in companies to a various degree, but they differ in how they can be influenced by external actors. They can furthermore either impede or potentially facilitate the adoption of CP, and thus the dissemination of CP in the industry.

The model that was used as a framework for this study (figures 3 & 4) presents all the influencing factors from the focal point of a company. The external ‘actors’ are thus also presented as ‘factors’ in that respect. For clarity it may now be good to distinguish between the main actors, and the other factors in the model. In terms of influencing possible promotion efforts, the relevant external actors seem to be the different authorities, universities, service providers, and industry associations. These actors can influence the companies *through* many of the other factors, such as prices, permits, financial support, benchmarking activities etc. They can also influence ‘internal’ factors, such as familiarity of CP, by providing information etc.

It can be said that all the main actors mentioned above, are relevant, and furthermore have scope to be more active in terms of promoting, and in general facilitating the promotion of CP. Most CP related work seems to have been initiated by research institutions. Some initiatives have also been undertaken by private service providers and within LA21 in Iceland. It seems however that these initiatives often receive little follow up, and positive results of CP work have not been actively promoted. There is limited capacity for these institutions to sustain long term promotion efforts. In general the examples show that many initiatives related to the promotion of environmental work in companies have difficulties sustaining themselves or are not actively pursued. Limited funding could be a problem in some cases. Another reason may be that there seems to be no actor responsible for overseeing or promoting systematic environmental work in companies and coordination is limited, making it hard to keep the issue on the agenda.

It is important that those actors which have the financial capacity to support and sustain promotion efforts in terms of systematic environmental work in companies show commitment to do so. By signing the international declaration on Cleaner Production, representatives of national and local authorities and from industry have committed themselves to support further work in this field. It is important that good intentions be put into action. Universities have furthermore not had a big role in this regard. Fishery authorities should also support such efforts. The effort to increase the value of fish catch provides a good framework for promoting CP. Universities have a role in training people and are thus crucial in terms of integrating and mainstreaming CP in industries. Involvement of students in CP work could also be beneficial for all participants.

NGOs, media and public can be considered to have a more limited influence in terms of CP, but perhaps through increased environmental awareness in the long term, reflected mainly in stricter regulation. ‘Suppliers’ can also be considered as external ‘actors’ but are not likely to ‘drive’ promotion efforts. It is however important that the products and services they provide coincide with CP efforts in a company.

Table 3 presents factors which are considered attractive for focusing future promotion efforts and elaborates why they are perceived interesting. These factors may be directly related to the roles of some of the actors, but the actors are not included as such. Note that it is not the intention to rank these factors, but to identify interesting

areas for further focus, when it comes to the promotion of CP in the industry. The factors are chosen based on the discussion in chapter 5, and the following **criteria**:

1. The main actors; national or local authorities, universities, service providers or industry associations, must be able to influence the factor;

The factors should also fit one or both of these:

- a. Provide a particularly interesting way to introduce / keep CP on the agenda in companies.
- b. Represent an area where there is dynamic, or ‘something going on’ which is likely to influence CP work in the companies.

	Factor ^{criteria}	Why?
Internal	Familiarity of CP and its benefits ^{1 a}	Little familiarity of CP is a potential barrier for adoption. Providing information about the potential benefits of such work is important.
	Quality improvement systems ^{1 a}	<ul style="list-style-type: none"> - Quality is high on the agenda, and quality management (QM) is widespread in fish processing companies (the HACCP system). - Have a preventative approach, like CP. - Integrate with CP → CP won't be ‘standing alone’ and thus better sustained in the long run. - Company does not need to adopt an entirely ‘new system’, easier to promote and implement.
External	The effort to increase the value of fish catch (AVS) ^{1 a b}	<ul style="list-style-type: none"> - The effort involves a range of actors and should be seen as providing a good environment to promote change processes, such as CP - The effort focuses on development in the whole fish industry → dynamic environment - Many goals of the effort are CP related, and CP supports the goals of the effort on the company level. → Thus support each other. - Provides financial support for research and development - Could thus provide a framework for CP promotion in the fish industry
	Waste water discharge costs ^{1 a b}	<ul style="list-style-type: none"> - Currently companies don't have to pay for waste water effluents. - Municipalities have to invest a lot, treatment costs are increasing. - Thus logical to apply the Polluter Pays Principle - Would give a clear financial incentive to adopt CP, and thus put CP on the agenda in companies - Should be coupled with a CP educational effort and general promotion
	Operating Permits ^{1 a}	<ul style="list-style-type: none"> - All fish processing companies require permits - Provides an active communication channel between local authorities and the companies. - Little ‘flexibility’ in permits can be a barrier for CP. - Requiring CP plans could put CP on the agenda.
	Benchmarking and info sharing ^{1 a}	<ul style="list-style-type: none"> - Comparing performance and learning from others is important for CP - Can facilitate CP processes and make them more effective. - CP could be included in existing benchmarking initiatives.

Table 3. Factors considered interesting for future focus of CP promotion efforts in the fish processing industry.

The factors in table 3 are those that are considered most interesting for focusing promotion efforts, based on the criteria mentioned above. That does not mean that others are not of importance, but they might be more difficult to influence. Long term stability is for example a prerequisite for long term planning in the companies, and thus for the effectiveness of CP efforts. It is thus a possible barrier; while long term stability alone would not automatically encourage CP adoption. Customer demand is a potentially strong factor, since companies respond to the demand of their customers, but cannot be influenced by external actors. The factors considered most relevant in terms of Icelandic fish processing companies are presented in figure 5.

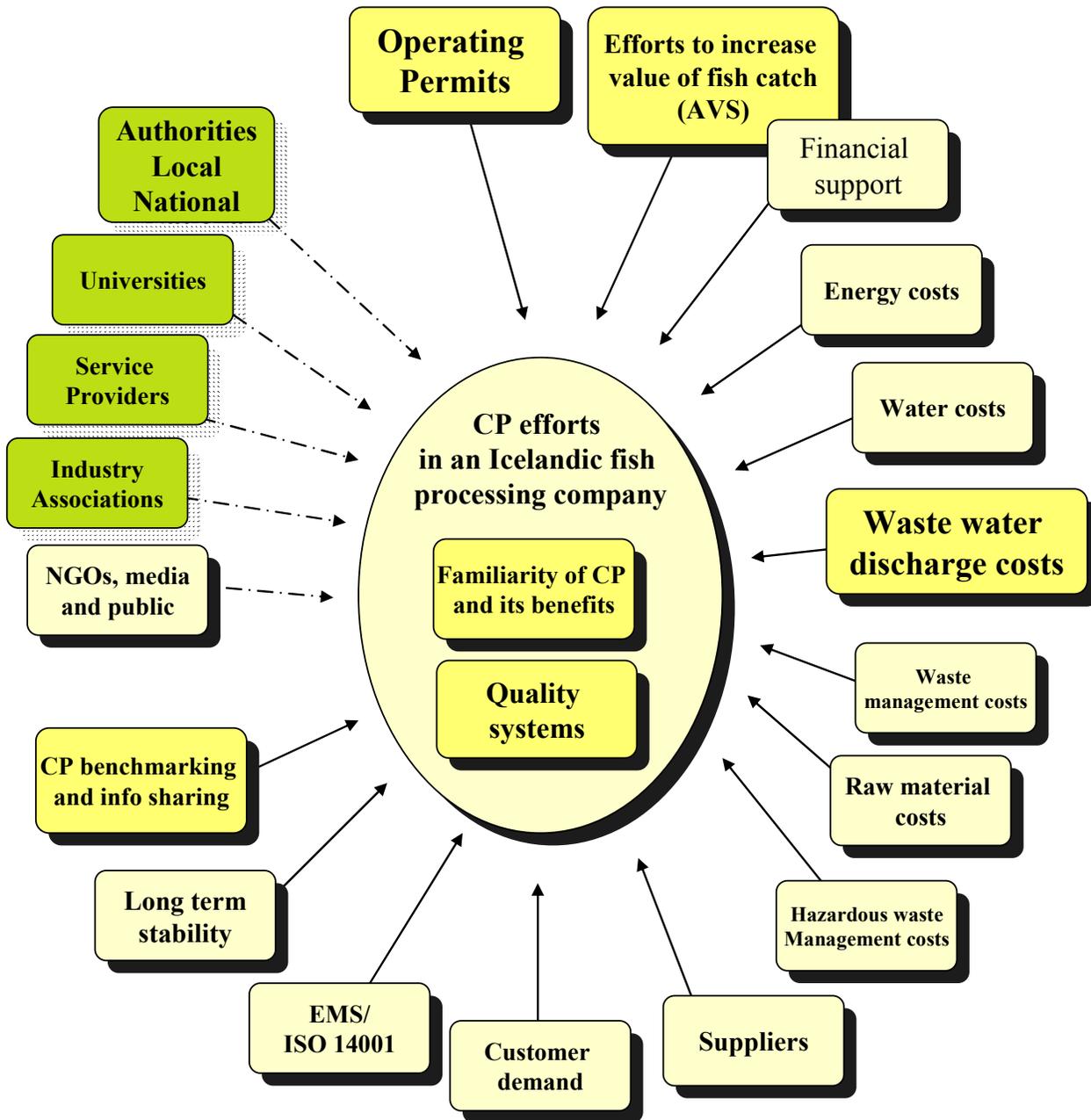


Figure 5. Factors influencing CP efforts in an Icelandic fish processing company. This model has been adapted from the general model shown in figure 4 based on the findings in chapter 5. It illustrates both the internal factors and external factors. The actors considered most relevant in terms of promotion efforts are presented in green. Most actors have substantial potential in terms of being more active in CP promotion and in giving a stronger incentive for adopting CP. Factors shown in yellow indicate areas where actors should focus their promotion efforts, to make progress in terms of CP adoption (See table 3). The broken arrows from the main actors are to illustrate that the actors often influence the company *through* any of the other factors, but not necessarily directly. Financial support is not considered for specific focus, but is to some extent related to efforts to increase value of fish catch (which explains the overlap of boxes).

6. Conclusions

This thesis has explored if applying Cleaner Production strategies can help to address environmental and economic concerns in the Icelandic fish processing industry, with the aim to increase its competitiveness and long range viability. Furthermore it has analysed a range of general factors known to influence CP efforts in companies, in order to identify interesting areas for focusing CP promotion efforts.

Examples show that there is clear potential in applying CP. Applying CP in a systematic way has been able to benefit companies both environmentally and economically, by increasing overall efficiency in the processing. CP thus offers a cost effective way to address environmental concerns leading to less costs and increased profits. In that way it concurs with two future concerns of the fish processing industry, to reduce costs and meet more environmental demand.

By exploring a range of factors internal and external to companies the study has identified several factors that are considered interesting for focusing future CP promotion efforts. These factors are presented in figure 5. A widespread effort to increase the value of fish catch in the next years can be seen as creating a positive environment for promoting CP, and could provide a framework for further efforts in that direction. Increasing costs of wastewater treatment for many municipalities gives a clear incentive for pursuing CP promotion and may become a point of leverage in terms of CP adoption in companies. Efforts should also focus on increasing the familiarity of CP, and the benefits systematic environmental work can involve, which seems to be limited among companies. Quality management is widespread in fish processing companies and provides a good opportunity to integrate CP, in order for CP not to be promoted as a stand alone approach. There is furthermore substantial scope for most actors to be more committed in promoting CP, give a stronger incentive for companies to adopt CP, and in general facilitate the adoption process.

In order to make progress regarding CP adoption in companies, the following processes are highly relevant to pursue:

- In terms of the role of different actors in future promotion efforts, it seems particularly meaningful to establish a clear responsibility to oversee and coordinate such efforts, not necessarily for fish processing specifically, but in general. The study was not able to find anyone that has a clear role regarding CP promotion. Furthermore, many CP related initiatives seem to have come to a halt or do not continue easily. Assigning this responsibility to some actor, would help to sustain initiatives and facilitate the adoption process. It could also be the role of such an actor to create networks between the relevant stakeholders and industries, and maintain the flow of information. This would also help to systematise the role of the different actors, and coordinate promotion efforts.
- Increased focus on wastewater discharge from fish processing can be expected to play a lead role in terms of how feasible it is for companies to adopt CP. The most logical would be to apply the polluter pays principle (PPP) and add levies on the wastewater discharge. This would provide a clear financial incentive for the company to adopt CP. Another option is to set discharge limits and let the company find the most efficient solution to reduce waste. These options are more feasible than requiring special end-of-pipe treatment. Authorities play here a key role.
- The permitting process provides an active channel to the companies through inspections. It would be feasible to seek ways to take advantage of this when it comes to CP promotion. Requiring companies to make CP plans could also be to put such work on their agenda. To sustain CP efforts it would be feasible to integrate CP into already existing quality management systems in the companies. CP could then also be integrated into promotion efforts focused on quality management in the companies.
- Future promotion efforts in the fish processing sector could be pursued within the framework of ongoing efforts to increase the value of fish catch, since the goals of the effort and CP have much in common. It could also serve to bring CP 'closer' to the companies, if the 'message' comes from within the industry. It

is also important that CP is promoted not only as a tool for achieving environmental benefits. It should be put into context of increasing the overall efficiency of the processing, and thus increasing the competitiveness of the company.

A few words on the approach and future research

The study has been valuable for getting an overview of the Icelandic ‘setting’, when it comes to the promotion of CP in the fish processing industry, and in general. In terms of comprehending the environment in which the promotion efforts would take place, the model (with the company as a focal point), has provided a good framework. There exists however substantial scope to look more thoroughly into some factors, for example the specific roles of the various actors when it comes to CP promotion. To improve the model it would also be valuable to look more in detail into the internal factors influencing companies, in order to further identify mechanisms that could facilitate change processes within a company. This could also help to understand how information can be effectively targeted and introduced to those companies that have less capacity to adopt new methods, as may be the case with SMEs. It would furthermore be interesting to explore to what extent quality work in companies does cover environmental aspects. And furthermore to what extent quality work might contradict CP objectives.

In retrospect it is worth reflecting briefly on the CP term for those working with it in Iceland. During the interviews the term sometimes posed difficulties, since it has apparently not been widely used. What is important is that CP stands for a preventive, systematic and integrated method to approach environmental concerns; increase efficiency and reduce wastes. For future work the Icelandic term used could therefore be chosen differently, if it was expected to reach better to the audience.

There is substantial scope for more research, and information gathering regarding how companies in the fish industry (and in Iceland in general for that matter) deal with their environmental issues. This is a field which is relatively unexplored in Iceland. Universities should there have a leading role, in cooperation with research institutions, industries and other relevant stakeholders.

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Appendix I. Interview questions - companies.

1. Where in Iceland does the company operate?
2. What are the main types of fish processing done by the enterprise?
3. How many employees work for the enterprise in general?
4. For how many years has the enterprise been operating?
5. Does the company export its products?
6. Are you or your company familiar with the concept and principles of 'Cleaner Production'?
7. If yes, where did you first hear of Cleaner Production? (Local authorities, University, Industry association, Research organisation etc.)
8. Has your company implemented any CP practices?
 - 8.1. Implemented a CP assessment?
 - 8.2. Mapped and carried out measures to systematically increase overall efficiency, raw material, water, energy etc.
9. Are these regularly monitored, measured?
10. If yes, which changes (other than in question 8)?
11. What was the main reason for implementing these changes? Environmental, economical or both?
12. Is there interest in implementing changes that can lead to both environmental and economical benefits for the company?
13. Would you be interested in hearing about such programmes and receiving relevant information?
14. From where would you prefer to get such information? (Industry associations, or authorities etc.)?
15. On which form would you like to get such information/support (Consultancy, brochures, webpages, loans/financial support)?
16. Do you believe there is a need for outside support to adopt CP?
17. Does the company have an environmental policy?
18. If yes to question 8, what were the main stimuli for implementing CP practices?
19. If yes to question 8, did the company receive any external support when implementing CP?
20. Is the company a member of an industry association?
21. Are you familiar with what is being done by related industry associations, research organisations etc.?
22. Are you familiar with CP projects in other fish processing companies?
23. If yes, has it encouraged changes in your company?
24. Do you generally watch what other companies are doing and exchange information (peers/benchmarking)?
25. What are the main management costs? (Water, energy, raw materials etc.)
26. Does/Has any of these costs been a driver for systematically increase efficiency, has something been implemented?
27. Are these costs tracked?
28. Do you think that there is scope to improve the environmental performance of the company?/ Do you believe that CP can benefit your company?
29. Would you do so if it was shown to be possible?
30. How important do you believe that outside actors motivate and provide information on CP?
31. From where would you prefer to get such encouragement (whom do you trust?) Industry associations, or authorities etc.?
32. What do you believe are the main barriers for implementing CP?
33. How important is it to manage the env.aspects of the production in a systematic way?
34. Do you feel outside pressure to make environmental improvements?
35. If so, from where is it strongest? (From authorities, customers, media, general public or others?)
36. Have you cooperated with universities, or other research bodies on developing new methods/technologies? Would you be interested in such cooperation?

Appendix II. Questions for follow-up survey in fish processing companies participating in CP demonstration project

1. Has the company continued work based on 'Cleaner Production' after the formal work ended in the companies in 1996? (For example on the tasks that had already started or were mentioned in the chapter 'tasks that the company will look at in the future' in the project report) YES – NO – PARTLY
2. a. If the last question was answered with 'yes' or 'partly', which are the projects/tasks that have been implemented?
b. What was/is the main driver for continuing CP work? Financial/cost saving, external pressure (from where?) or other (which)?
c. Have the benefits of CP projects been compiled (calculated) and if so have they brought anything financially, image wise, market wise etc.?
3. If question 1 was answered with "No", what do you see as the main reasons for not continuing the CP work after the formal project ended?
4. Is there need for more motivation (or assistance) from external actors for CP work to begin and/or continue? YES - NO
5. From where would it be preferable to receive such motivation (or assistance)? Research institutions, Authorities, 'Inspectorates', Industry associations, Service providers/ for example consultancies or others?
6. In which form would it be preferable to receive such motivation? (For example as instructions on the form of subsidised consulting, information through information centres/networks, as economical incentives and then which, as increased demand through law and regulations or other?)
7. What is the number of employees in the company?