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Logistical and handling solutions: Hydrogen Peroxide

- The supply chain for the Norwegian fish farming industry

Master of Science Thesis in the Master Degree Programme, Supply Chain Management

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Abstract

In the beginning of 2010 Eka Chemicals entered a, for them, new market and started delivering hydrogen peroxide to the Norwegian fish farming industry to be used as a de-lousing agent for the salmon lice problem. As Eka has traditionally delivered the product to large fixed storage tanks in the pulp and paper industry, the logistics for fish farms have been a complex matter. The method used to get an understanding of the current situation was mostly qualitative interviews from the actors that are involved and internal sales figures from Eka Chemicals. The market is growing rapidly and has a large seasonal variation, which is unprecedented at Eka, creating problems with uneven flows and an overburdened supply chain.

From the investigation of the present situation, it was clear that the problems not only occurred at the transport or the supply chain planning stage, but already in the order handling stage, where delays were common and caused problems further down the chain. Hence a more formal order handling was proposed to make sure orders go through the proper channels at the right time. This would lead to responsibilities being properly divided and activities could be measured, preferably within the already existing SAP-system, in order to be improved. The market is quite spread out presently and an area focus was suggested in order to establish the product and method in this new segment and to show internally and externally that this is a business area for the future.

Keywords: supply chain, logistics, hydrogen peroxide, Norwegian fish farming industry, transport mode, environmental effects, information structure, market analysis, seasonal variation, increasing volumes.

Table of Contents

List of tables

1. Introduction

The introduction chapter gives a general description and overview of the product and what the logistical concerns involved are, in order to fully understand the situation as well as the outcome of the thesis. It includes background information followed by the purpose of the thesis, problem analysis, the set limitations and an explanation of the outline in this report.

Hydrogen Peroxide (HP) is most commonly known as a bleacher in the chemical industry as well as the pulp and paper industry but its scope of use extend to other industries as well. As the large pulp and paper industry has matured and the competition has lowered the profit margins in this area, Eka Chemicals (Eka) is looking to extend their special applications sales. They have been instrumental when it comes to developing markets in the past and adapting their products for the set task which is one of the major reasons Eka has become the company that they are today. Eka sees this as future possibilities and even has innovation as a core value, many times working together with their customers, developing the processes to enhance both sides.

One of the interesting areas is the Norwegian fish farming industry where salmon lice are a big problem, causing a damaged or deceased salmon, costing the industry large amounts. The Norwegian market for hydrogen peroxide, used for de-lousing the salmons, is growing at a rapid pace which started with the first delivery in 2010, providing the supply chain with large structural challenges. Complicating the matter even further is currently a large seasonal variation since the delousing is only performed twice a year and a forecast that predicts a doubling of sales in 2011. The variations are not large compared to Eka's total production but for this market alone it is definitely a factor to consider.

There are alternative methods for de-lousing salmon but their effectiveness has dropped due to the lice developing resistance towards them. The use of HP is only one of the available methods on the market, but has proven to be very effective, although difficult to use due to the large amounts that require extra handling. HP is Eka's only product on the market and they are focusing the development on more efficient ways of using the product rather than new products to solve the problem with salmon lice.

The supply chain is complex compared to how Eka usually deals with their customers, where the common method is to deliver large amounts in bulk directly to the customer. The customers often own a storage tank that is monitored and kept at specific levels by Eka and the hauler, which is shipped by full truck loads straight from Eka's production sites to the end customer, usually large actors in pulp and paper as previously mentioned.

In the case of the HP sent to fish farms, Eka is collaborating with a distributor in Norway who handles customer relations and brings the medical knowledge of distributing pharmaceutical products in Norway. This is due to HP being considered a pharmaceutical product in the de-lousing operations unlike when used in other operations. The hauler involved in the supply chain is the sole hauler used by Eka for all regular transportations to and from Norway. The distributor and the hauler are not mentioned by name in this report due to secrecy agreements.

Currently the supply chain is suffering from many late orders causing disruptions to long term planning and problems with destinations being mobile when required to meet a ship coming to a certain harbor causing delays and difficulties. Further problems include expensive or lack of storage close to customers, the seasonal variation and the increasing volumes, which all can contribute to it being difficult to get enough of the product to the customers at the right time for it to be satisfactory.

The task is to evaluate the current logistical solution and also present alternatives that are of interest to Eka Chemicals and their closest collaborators. This must also solve the structural problems such as alternative transportation modes, restrictions regarding the laws of each country and also the different actors within the supply chain.

1.1. Background

1.1.1. AkzoNobel

AkzoNobel, a global fortune 500 company, is present all over the world with more than 55 thousand employees in over 80 countries but the headquarter is located in Amsterdam since this is where AkzoNobel is originally from. They are the largest global paints and coating company in the world, with a yearly turnover of almost €14 billion, and are in the top regarding specialty chemicals, which is where hydrogen peroxide is included.

Along with their large environmental and sustainable focus they also value entrepreneurial thinking as well as a customer focus. They are currently top three in Dow Jones Sustainability Index and sustainability is clearly a core value. (AkzoNobel, 2011a)

AkzoNobel has an extensive environmental work and has, for example, set goals of reducing their cradle-to-gate carbon footprint per metric ton of product by 10% in 2015 and by 25% in 2020, both compared to the emissions in 2009. (AkzoNobel, 2011b) The sustainability process is, according to AkzoNobel (2011c), firmly and fully integrated in the regular business processes and strategies. Sustainability is clearly a focal subject for AkzoNobel and is *"at the heart of everything we do"* (AkzoNobel, 2011c).

1.1.2. Eka Chemicals

Eka Chemicals is a Business Unit within AkzoNobel situated globally around the world. Their main focus is the customers within the pulp and paper and chemical industry divided into three regions, Europe, Americas and Asia-Pacific. (AkzoNobel, 2011d) Besides their products for these industries they also offer specialty chemicals for water treatments and packing materials, for example. (AkzoNobel, 2011e)

As expected, Eka shares the goals and strategies of AkzoNobel but also focus on their own visions such as growing through innovation as well as developing related businesses. Here, sustainability can also be found as one of the cornerstones of the company and has been for many years, illustraded by their goal of making their eco-premium products at least 50% of their total sales by 2012 (AkzoNobel, 2011f). Eka was founded in 1895 in Bengtsfors by Alfred Nobel and started producing hydrogen peroxide 1930 due to economies of scope from the chlorine production already in progress. (AkzoNobel, 2011a)

1.1.3. Hydrogen Peroxide

Hydrogen peroxide was first produced as a technically usable product in the beginning of the 20th century. (Eka Chemicals, 1997) It has a sharp smell and is a colorless liquid soluble in water and in ethe. (Swedish Chemicals Agency, 2010) Since oxygen is willingly emitted by HP, the substance is a very effective oxidant. This process can be accelerated by factors such as metals, metallic salts, alkali and heat.

1.1.3.1. Producing

Eka Chemicals produces HP at several locations such as Alby and Bohus in Sweden, Rjukan in Norway as well as in the US and Venezuela. HP is delivered and sold after being stabilized with water and small doses of substances giving it a certain degree of tolerance towards unintentional contamination. The final concentration of hydrogen peroxide is then roughly 35, 50 or 70 per cent where weight per cent is always used.

The process is very energy consuming but the largest cost related to producing hydrogen peroxide is the raw material used. Natural gas is bought in order to produce the hydrogen gas at the Bohus site. (Staberg, 2011) The main difference between the production locations is the production cost, due to sites using different production solutions regarding electricity and hydrogen gas.

1.1.3.2. Transportation and handling

The transportation and handling of HP is heavily regulated through laws and classifications applicable on the means of transportation. For example air freight of hydrogen peroxide is only allowed for compounds up to 40 weight per cent. (Eka Chemicals, 1997) During transport, the HP should be packaged in containers with vented caps, otherwise there is a risk of the container bursting. (Hydrogen-Peroxide.co.uk, 2010)

The HP can be transported in different vessels, such as containers, tanker trucks or tank wagons which can hold as much as 27-29, 34 and 68 tons respectively (Rahmquist, 2011a). The majority of the transportations involve ISO-containers which is a standard unit for containers but it becomes a limitation as they can only hold between 27 and 29 tons of HP. Containers can be used both on truck but also on railway and they are flexible since they can be used as storage but associated with high costs. HP is primarily transported and sold in concentrations of 49.5 % due to classifications for transport regulations – concentrations greater than this are subject to more stringent and costly regulatory requirements. No other concentrations will be considered here. All figures concerning HP will be with the transportation concentration in mind, so numbers can be compared more easily.

1.1.4. The fish farming industry

Norway is a very large producer of salmon, amounting to one million tons every year which makes this one of the main industries in Norway, only exceeded by China in fish export globally (Workman, 2007). The salmon are grown in large net enclosures along the Norwegian coast until fully grown (Hartmann, 2010). It takes around 16 months for a salmon to grow to a reasonable size for slaughter (representative-distributor, 2010). The enclosures are up to 160 meters in circumference and can contain 200,000 salmons (Larsson, 2011).

When the salmon lives in the wild, it is naturally infected by parasites, salmon lice for example. However, when the salmon is grown in enclosures this parasite reaches unhealthy proportions and can eat through the skin of the salmon, exposing the flesh to the salt water. This leads to a damaged product or even to the death of the salmon. Up until recently this has been treated with a biological pesticide but the lice have grown resistant to this treatment so the growers had to once again turn to the use of hydrogen peroxide. This was used as early as the beginning of the 1990s but replaced by the cheaper and more manageable biological pesticide which required much smaller quantities for the same result. (Dalin, 2011)

Going back to 1989-90, scientists within Eka Chemicals believed that hydrogen peroxide could be used to help the Norwegian fish industry with their parasite problem, so they contacted an institute in Norway and sponsored research to be done within this field. As Eka were the owners of this research, they could claim the patent rights to the process which was developed to remove the lice from salmon. (Hartmann, 2010) (Larsson, 2011) The patent has since expired, but Eka Chemicals has once again become a large actor in this sector. The process is quite simple in theory when performed in a controlled environment, but becomes more complex when it has to be performed on site at the different salmon net enclosures. The idea is to keep the fish in a crowded container of some sort, add hydrogen peroxide to receive the correct concentration for the correct amount of time, and then replace it with water to rinse off the salmon. (Hartmann, 2010) One treatment can be used for 150 tons of salmon and takes around 30 minutes (representative-distributor, 2010).

The use of hydrogen peroxide on fish is a prescription drug which needs a veterinarian's approval to decide the levels and dosage, before administered, although the veterinarian does not need to be present (representative-distributor, 2010).

1.1.5. Customer location

To get a better understanding of the production in Eka and its customers, a map (Figure 1) is provided of the three production sites and the six sites which Eka plan to deliver to during 2011, according to their forecast. The three production sites are as mentioned earlier, starting in the north with the house markers; Alby, Rjukan and Bohus. The customers are symbolized with a fishing marker and again starting from the north; Bodø, Ottersøy, Namsos, Frøya, Fosnavåg and Bergen. The percentage number next to the location name represents percentage of total forecasted sales for 2011. This is to give an idea of where the customers are located and where the majority of the product needs to be delivered.

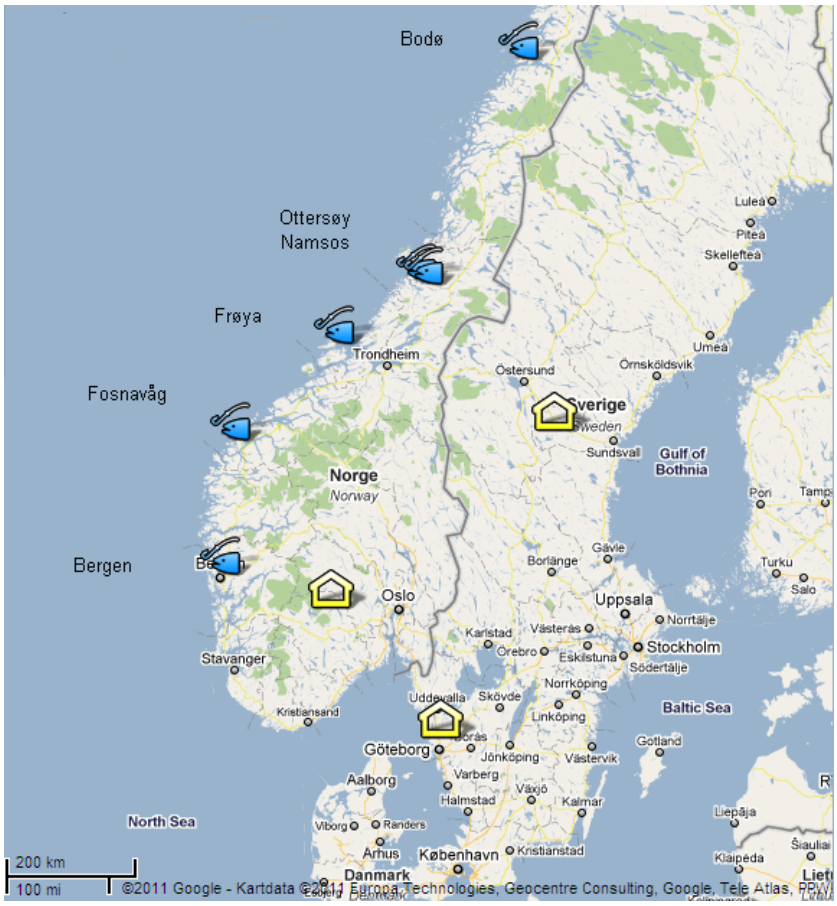


Figure 1, Map of production sites and customer location.

1.2. Purpose

The purpose of the thesis is to describe the current supply chain regarding hydrogen peroxide within the fish farming industry and to also describe the advantages and disadvantages of the same. The thesis will also identify potential improvements regarding the transportation and handling solutions in order to achieve the best possible outcome for Eka. This will include an overview of the current actors involved in the supply chain and the most suitable level of collaboration.

The thesis objectives are to evaluate the suitability of the current solution which is dependent on two countries separate regulations such as road transportation and the transportation of dangerous goods, just to mention a few. The cost of handling, storage and transportation will be estimated and compared between various alternatives as accurately as possible. Finally, the environmental impacts will be assessed generally in order to see the differences and risks that relate to the transports.

Even if the thesis is carried out with Eka's best interest at hand, a solution that satisfies all current actors in the supply chain is preferred to encourage future cooperation. The problems that require consideration include determining which factory to source from, what transportation mode should be used and how to overcome the geographical problems in Norway. A solution for how to solve storage is also a key issue for the supply chain.

The following research questions will be answered to fulfill the purpose of the thesis:

- *How is the current supply chain structured and what advantages/disadvantages does it bring?*
- *What modes of transportation are suitable for delivering the hydrogen peroxide to the coastline of Norway?*
- *Are there any possible solutions regarding the storing of the product closer to the customer?*
- *How is the product allocated from the different factories? Is this a factor to improve?*
- *What does the optimal supply chain look like and why is this solution the most suitable?*

1.3. Problem analysis

When producing a commodity product in a mature market, it is always important to cut costs wherever possible along the supply chain to stay competitive. In this case it is still a commodity product but in a brand new market, with a large growth potential where it may be worth doing investments to ensure customer satisfaction and service level. The three biggest costs in this equation will be the freight cost, the container lease cost and capital for possible investments. These will have to be weighed against the possibility of securing future market shares and the uncertainties of a new market.

The two main problems that differ compared to other markets for the same product are the seasonal variation and the fast growing market. The newly sprung market also has some consistency problems with delivery locations and delivery times due to limiting factors from the customer side. To get an understanding of the market, the actors and the relationships between these, an introductory analysis of the market has to be conducted which take into account the owner structures.

The logistical solutions such as transport modes as well as cost efficient transports are key issues as well as the overall supply chain structure. Last, but not least the environmental and sustainability aspects of each alternative will be considered to ensure they coincide with the goals Eka and AkzoNobel have set for their operations.

1.4. Limitations

In the report, there have been several limitations imposed in order to present a plausible recommendation. These limitations have been selected with respect to the changes and risks inflicted on the final report. There have also been selections with respect to standard procedures within the industry as well as some reasonable logic and findings that are considered general within the industry.

One limitation that has been made is regarding the potential and existing market. The report has only analyzed the existing Norwegian fish farming market, especially salmon. In order to consider other fish farming markets, it would require large knowledge regarding the possible problems and solutions to the specific markets and it is therefore a complete new set of problems if it would become an actual possibility. Also, regarding other nationalities as a market would require a much deeper understanding of both the market development as a whole and also the strategic possibilities and interests of Eka Chemicals.

Throughout the report, the calculations are based on HP in concentrations of 49.5 % which is the final product that is sold to the customers. Also, future or present production capabilities and limitations thereof have not been focus of the report.

There have been some limitations regarding the fact that it is a product classified as dangerous goods. One could go in much more in this complex situation and explore all the different options in this matter. However, it was assumed in this study that the current way of handling and transporting the dangerous goods is satisfactory and therefore not a variable when looking at the different alternatives. Eka both produces and sells different concentrations of hydrogen peroxide as well as other products. These are of no concern to the report and will not be of interest to the outcome.

The environmental impacts of this product and its supply chain can be divided in three parts, the first being the external effects of the transportation. This will be considered and used as a deciding point for the final recommendation. The possibility of accidents occurring during transport and contaminating the environment is estimated to be roughly the same for tank trucks and containers on trucks; hence this potential impact will be disregarded. Finally the usage of the product and the long term effects on the sea will be left to the appropriate experts who are already involved in this project, contracted by the distributor.

The report only deals with market changes and competitors from a general point of view. It is not the intention to analyze the other actors and their supply chain in the same way as Eka and its supply chain. This is due to the wish and preference of Eka as well as the fact that this would greatly exceed the time span for this thesis.

The handling costs of every specific alternative and transport mode will not be measured and calculated. In many cases, an estimate will be used along with common practice as well as information from Eka. This will still affect the total outcome in the right direction but for more exact numbers, calculations and measures should be made.

The forecast and expected sales numbers were provided to us by Eka. It is not our intention to review the forecasting process of Eka and therefore these numbers are the primary basis of our evaluations in this report along with other information and aspects found.

Another limitation is the decay of the product. Hydrogen peroxide has a decay of about one per cent per year at room temperature. This will not be accounted for due to directions from Eka and it is not plausible that it would change the final outcome since there are several other unsecure variables that could result in a bigger possible difference.

1.5. Outline

The abstract provides an overview summary of the thesis in order to quickly get the answers one might be looking for. It briefly describes the problem, the work carried out, and brings forward the final recommendation.

The current chapter, the introduction, describes the focal company along with background information regarding hydrogen peroxide and the fish farming market. It also puts the problems in the right context and describes the purpose.

The frame of reference is there in order to help understand the concepts as well as the different models and theories used. It is, as stated, a reference which the thesis analysis work relates to. It also described the sustainability aspects of transportation from which the environmental aspects in the report derives. The method chapter presents the structure of the work together with how the process was carried out. The structures of the interviews as well as the collection of information are key areas presented in this section.

After the process and the background information have been described, the empirical findings are presented. This section describes the information found and processed through the models and theories explained earlier. In order to better understand the full picture there are also more in-depth descriptions of the situation as the authors see it with support from the frame of references. It also contains the possibilities and constraints of the different transport modes.

The report then moves on to the analysis which discusses the main problem areas addressed, starting with the more general areas and progressing to more specific areas. This chapter also includes the proposed changes as well as potential savings estimated in order to give a good overview of the full potential.

The discussion chapter states and summarizes the outcome of the analysis and also presents the main recommendations resulting from the thesis work. The connections and links to the problem areas are briefly explained and discussed. The last chapter presents the final recommendations and states which aspects that are important to consider when going further with the recommended changes.

2. Frame of reference

In this section the theory and the models that are used throughout the thesis are described. These are the tools for the analysis performed later in the thesis. With models such as Porter's five forces the further work can be related to a reference and is therefore easier to combine with the information provided or found. Through the theory of inter-organizational relationships the situation which Eka is in can be explained better and thereby make more use of the results. Obviously, the environmental aspects are part of the chapter in order to understand the theory behind the effects.

2.1. Supply chain and networks

The term supply chain is traditionally defined as the supply of and to the consumer, from first supplier to the final customer (Lumsden, 2007). The supply chain consists of tiers of suppliers that are linked to the focal company and its customer tiers, representing both the inbound and the outbound logistics (Harrison & van Hoek, 2002). The supply chain can be used both in a business-to-business (B2B) and business-to-consumer (B2C) environment and can be viewed as products going downstream or money flowing upstream (Figure 2). Harrison and van Hoek (2002) propose that it is possible to compete with logistics through meeting the end customer's demand by supplying what is needed in the right form, when it is needed, at a competitive cost.

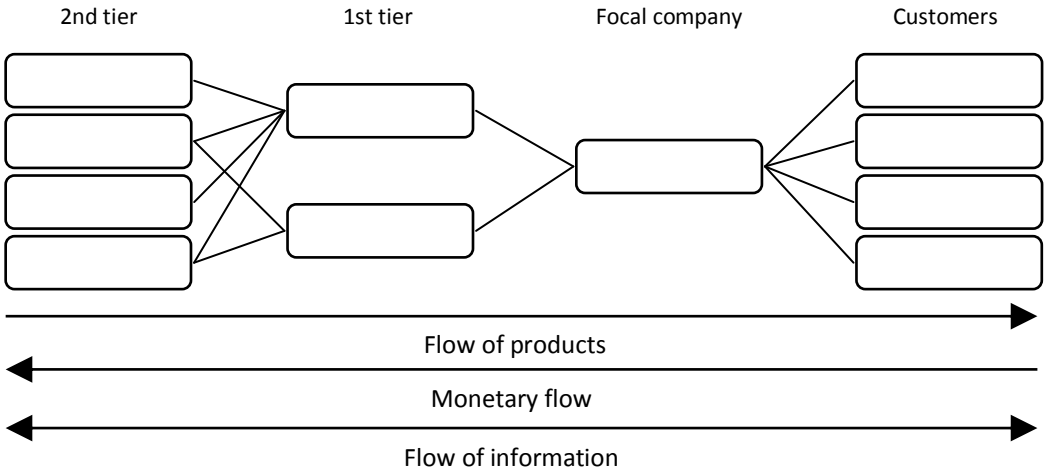


Figure 2, The supply chain network.

Traditionally it was the flow of material that was seen as the primary flow of logistics. It consists of large values which has a direct effect on the environment and requires large resources to perform (Jonsson & Mattsson, 2005). It is primarily raw material and resources that go downstream and the majority of upstream goods are returns and recycling. Jonsson and Mattsson (2005) points out that the information flow consists of customer demand, available capacity, utilization and available material within the own company as well as ones suppliers capacity. Most commonly, some kind of shared IT system, such as an ERP-system, is used to track this in real time. The monetary flow is initiated by an invoice or other predetermined mechanism and flows in the opposite direction of the material flow.

Being part of a network can bring many benefits but it does require some additional considerations when making decisions. The decision made by the focal company will not only affect them, but every actor in the network, perhaps in different ways, making it a complex and multidimensional task to know the exact consequences of a decision (Gadde & Håkansson, 2001). To achieve benefits across the board, one must think and plan in network terms. It may be necessary to explore the network boundaries to develop the thinking and to formulate new strategies.

2.2. Service level

Harrison and van Hoek (2002) describe the quality of supply chain as the service level the customer is provided with. This can be dependent on unavailable product, defects and how fast they are solved and late deliveries. The service level can also consist of the focal company providing the customer with technical know-how and education, which can lead to customer service enhancement by exceeding customer expectations. A more practical approach to service level is given by Jonsson and Mattsson (2005) who base it on how well the focal company can adapt to a changed customer request on a current order. This can include changing the time of delivery, change in quantity or even destination of delivery. There is a distinction between the focal company's ability to meet changes in demand before the order is received and during order, meaning the time from order to delivery. As Figure 3 shows, customer service is based on three aspects; delivery service, information exchange and logistical services (Jonsson & Mattsson, 2005). Information exchange is beneficial for everyone concerned as it can decrease the delivery uncertainties, something that can be very costly.

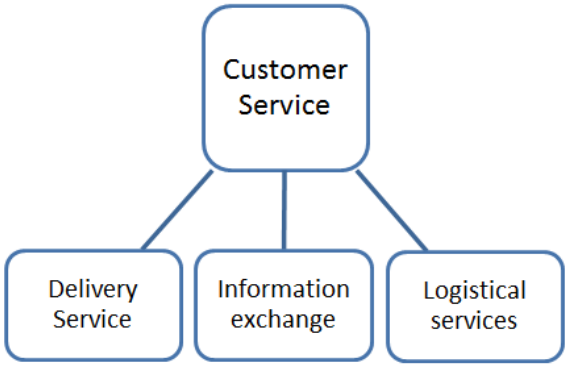


Figure 3, Customer Service.

To achieve a desired service level it is important to be aware of what the customer actually values and that should serve as the basis for customer service priorities (Harrison & van Hoek, 2002). These factors should be visible to every actor in the network to facilitate the progress of the performance. Robust, dependable processes are desired both from an external perspective as well as an internal one to be able to trust the process and reduce costs by eliminating errors. This can give a flexibility advantage as the processes capabilities are known and less adjustments are needed in time restricted situations. (Harrison & van Hoek, 2002)

2.3. Agile supply chain

An agile supply chain is a gathering of flexible processes that can adapt to turbulent markets rapidly while at the same time manage low volume products, according to Harrison and van Hoek (2002). This requires a focus of customers and their needs and staying up to date with these, ready to meet any change that may come. The suppliers included in the process are an important part of achieving high customer satisfaction as it is not one actor alone capable of this, every trading partner becomes a vital link. Agility is not about short lead times (even if it can be beneficial to achieve the primary goal) nor offering the same service with less resources but actually the ability to respond to changes in demand. (Power, Sohal, & Rahman, 2001)

Supply chain agility is a network's ability to consistently identify and engage in business opportunities before ones rivals. This can be facilitated by well functioning relationships within the supply chain to keep a high level of customer satisfaction (Li, 2009). Christopher (2000) defines agility as business-wide capability that embraces not only organizational structures but also information systems, logistics processes and, perhaps most importantly, the mindsets of everyone involved. The key word throughout the supply chain must be flexibility.

2.4. Seasonal variation

This means that the product has a distorted demand over the course of a year. The product can for example be more popular during the summer months, such as ice cream and garden furniture, for obvious reasons. The sale of toys will instead go up before Christmas and high fashion has two main seasons and two shorter ones, where each may only last for a couple of weeks. In extension this means that it will be hard to level one's production as demand is all over the place. (Harrison & van Hoek, 2002)

There are two main ways of counteracting seasonality, which will depend on the product and the market. A chase production approach can be used to satisfy increased demand during shorter periods of time. This will be done by implementing extra shifts, paying for overtime or, perhaps as a last resort, employing a hire/fire policy to keep only the personnel needed. This is mostly adaptable in an industry with high manual labor or a production site with demand on personnel being present. An automated process with very high fixed costs would not be able to implement this. For this kind of operation a leveled production approach might be the better choice, where the production is stabilized and continuous during the year, building up a finished goods inventory in anticipation for the increased demand. (Inman, 2011)

Another way of evening out the demand is to influence the customer to buy when it is more beneficial for the producing company. This is most commonly done by having a pricing strategy that can push some of the demand from the peak towards the dips. (Lumsden, 2009) For this to work a comparison between the costs of carrying the finished goods inventory versus the loss of revenue from a lower price must be done.

2.5. Warehouses and storage

To be able to provide a customer with a desired service level, it may be necessary to provide storage closer to he customer, which can be done in several ways. Common approaches are centralized or de-centralized warehouses or distribution centers. Centralized inventory is advantageous in terms of inventory-holding costs and require less total inventory for the same level of safety stock. This is important for high-value goods where there is a need to keep inventories to a minimum but it will also make it increasingly complex to respond to local market opportunities. De-centralized warehouses bring a greater risk of product obsolescence and higher inventory holding costs, but in return offers increased flexibility and a lowered transport cost. (Harrison & van Hoek, 2002)

Storage costs exist in most manufacturing companies and come from finished goods stocks, waiting for transportation, distribution stock and usually ending up in a material stock at the customer (Jonsson & Mattsson, 2005). Stocks can be used to balance peaks in demand across regional markets and central warehouses are usually relevant when inventory costs are more important than the distribution costs (Harrison & van Hoek, 2002). This applies for products which have a high cost per volume unit, usually not a bulk product as distribution costs have a marginal impact on logistical costs per product, when considering the transport costs as based on volume and weight. An exception applies to products which require special attention during transport, such as art (fragile), confidential documents (security) or dangerous goods, which all might have a different operating environment. (Harrison & van Hoek, 2002)

2.6. Transportation in general

The transportation industry has had a steady increase due to three factors: innovations in transport technology, commoditization of transport (primarily due to container ships) and the oversupply of available transport. This has meant physical distances are less of an issue, even for bulk transportation, meaning it is possible to stay competitive with competitors on far away markets. (Harrison & van Hoek, 2002)

There are many types of distribution available; most of them focusing on utilization and truck fill rates. One of these is the hub distribution, sometimes referred to as hub and spoke, which gives a high utilization of the resources used together with frequent transports and high flexibility. It does, however, also bring long lead times due to waiting for goods to be consolidated and increased handling of the goods. For it to be truly efficient, a functioning goods tracking system is required. (Lumsden, 2007)

The split point distribution system (Figure 4) is dependent on weight and volume, working with unit loads final destination points being close to the split point. The flow of goods can be uneven to the split point if large shipments are sent periodically but will be cost and transport efficient. It may require less handling but even if the distribution is somewhat direct, the large quantities lower the average lead time. The most efficient way of transport is using direct relations between two actors and having full truck loads to occupy the distance. (Lumsden, 2007)

Lumsden (2009) presents four types of cost associated with optimal carrier size. First off is the direct line and supply cost which is linked to each vehicle used and its fixed costs. Using terminals will increase the cost as a larger carrier requires more time and resources to consolidate and organize larger loads. The third cost is the time spent on the road and in warehouses and increases the cost of tied up capital. Finally and perhaps most importantly, is the cost of external effects that will dramatically decrease when carrier size increases. This is simply because fewer trucks, trains and vessels are necessary to perform the same amount of work.

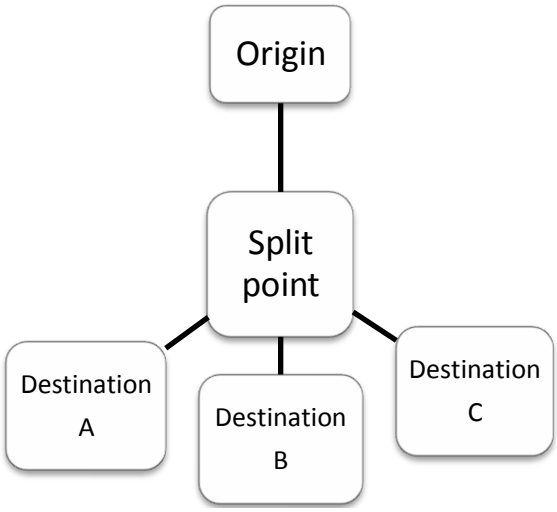


Figure 4, Split point distribution system.

Being a transport provider, or even a buyer, means dealing with a special service as it cannot be stored and it is very much dependent on time and location benefits. Goods are worth more at a certain location, delivered at the right time providing value for the society by three factors: service, technique and economy. (Lumsden, 2009)

2.6.1. Single wagon load

The single wagon load is the railways equivalent of road transportations hub and spoke system. As Figure 5 shows, this system is capable of consolidating wagons from different sources to one large train, dropping them off at specified locations and adding new wagons before arriving at the end destination. The re-arranging of the wagons is done at a marshalling yard and wagons (or containers) can be brought there by either feeder train or a truck of some sort. (Rail Freight Portal, 2011) The departure times are predetermined and can be resembled to a timetable of a bus. Single wagon loads are responsible for 50 % of the European cross border rail freight, amounting to 100 billion ton-km (Rail Freight Portal, 2011) (CER, 2010).

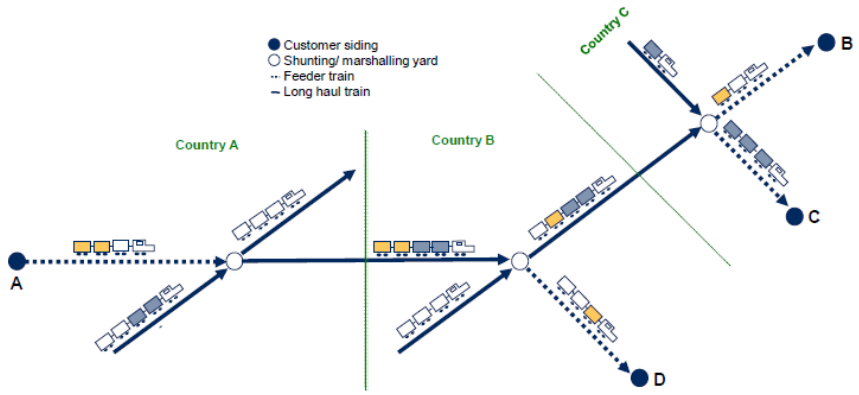


Figure 5, Single wagon load (Xrail, 2010).

The system is quite flexible, allowing for customers to know departure times in advance and offer them the possibility of adjusting their volumes on a day to day basis (CER, 2010). However, there are problems with transport reliability and transport information. This creates problems as there is fierce competition from the trucking industry and they have a massive market advantage in full truck loads compared with single wagon loads with nine tenths of the market (Xrail, 2010).

As railway has 90 % of its costs in fixed costs, they need to find ways of increasing their volumes. One way to do this is to make it more customer friendly, which is the idea of the newly created Xrail collaboration between seven major operators in central Europe. These include DB Schenker in Germany and Green Cargo in Sweden. (Railway Gazette, 2010) Despite this, the overall network coverage is declining in many countries, including Spain and Norway (Xrail, 2010).

2.7. Inter-organizational relationships

Relationships on different levels have always been a part of companies and some see it as an obvious structure and pay little attention to it. Others realize that this can be a way of gaining competitive advantages and embrace the relationship. In a globalized world, it is just about impossible to expect one organization to include the competence and means of supporting a product from raw material until it is in the hands of the end user. This calls for a need from external sources that work for the organization or a joint collaboration that use each other's strengths to their advantage. If the product is standardized and all competitors offer the same, something must distinguish them from each other.

2.7.1. Network and control

This leads to a battle between supply chains and how cheap it is possible to manufacture, transport and have it available for the customer along with the desired service level and delivery precision (Skjoett-Larsen, Schary, Mikkola, & Kotzab, 2007). This provides the focal company with the benefits from its own organization as well as its business partners. To fully utilize this extended network with deepened relationships, the managers' capability of developing and maintaining trust-based, long-term relationships are crucial.

The extended network can be viewed as heavily dependent on social capital as it influences the formation of the network and affects the industry growth (Walker, Kogut, & Shan, 1997). Even though different views are presented, they all come together and agree on that the network formation is dependent on social capital. It is also suggested that individual agents are necessary to overcome the "structural holes" that exist in relationships and are hindering the collaboration in some way. An individual entrepreneur can seek out these gaps in information which will transform the network structure (Burt, 1992).

At first glance it can seem like only positive changes come with engaging in closer relationships, but as most things, the complexity it brings can be expensive to handle. Dekker (2004) identifies two control problems when engaging in inter-organizational relationships: the management of appropriation concerns and the coordination of tasks. This creates an increased need for monitoring and control between organizations in the supply chain. Furthermore, it can lead to a decreased overview of the flow between organizations concerning planning, budgeting and control, making it hard to actually

acknowledge what makes the organization successful. Most failures in inter-organizational relationships come from the difficulty of managing them, putting more pressure on managers and what structure is chosen for the relationship. Dekker (2004) concludes by stating that many of the problems can be avoided or mitigated by simply choosing a 'good' partner and this reduces the need for expensive formal governance, although exactly how to know a partner is 'good' beforehand is not mentioned.

The matter of control is also a trade-off with flexibility. With lower control needs, the possibility for higher flexibility increases and vice versa. These concepts are both multi-dimensional, however, which makes the trade-off a more complex matter than first expected since a company's fully controlled area may also be attained through resource control from its co-operation with other companies. (Gadde & Håkansson, 2001)

2.7.2. High- and low-involvement relationships

Low involvement in the relationship with suppliers leads to a so-called 'arm's-length relationship' which means avoiding entering any mutual adaptations or linking activities. The low-involvement relationships have lower handling costs since there are only simple transactions performed but there may be increased hidden costs within the company due to necessary adaptations within the company to fit the available supply. Also, there is a possibility of increased delivery uncertainty and therefore the need for a buffer, or safety stock, is enlarged. The risks associated are in this case external and more difficult to monitor compared to when the supplier is part of a high-involvement relationship where the risk then may be seen as internal and easier to adapt accordingly. (Gadde & Håkansson, 2001)

Examples of high involvement-relationships are when the companies develop and improve products or in some way the combined knowledge and skills are put to good use for the sake of both companies. High-involvement relationships are often costly but also more beneficial (Gadde & Håkansson, 2001). The benefits are mainly increased revenues through, for example, better quality while the adverse aspects especially include large costs.

A high-involvement relationship follows investment logics in many aspects. There are often large start-up costs and is beneficial after some time. The adaptations needed have already been done and there are greater possibilities in reaping the associated benefits. See Figure 6 to see the theoretical costs and profits for both high- and low-involvement relationships. There are also obvious risks of lock-ins, i.e. forced to stay with the selected supplier, which may develop negatively compared to other possible routes for the company. (Gadde & Håkansson, 2001)

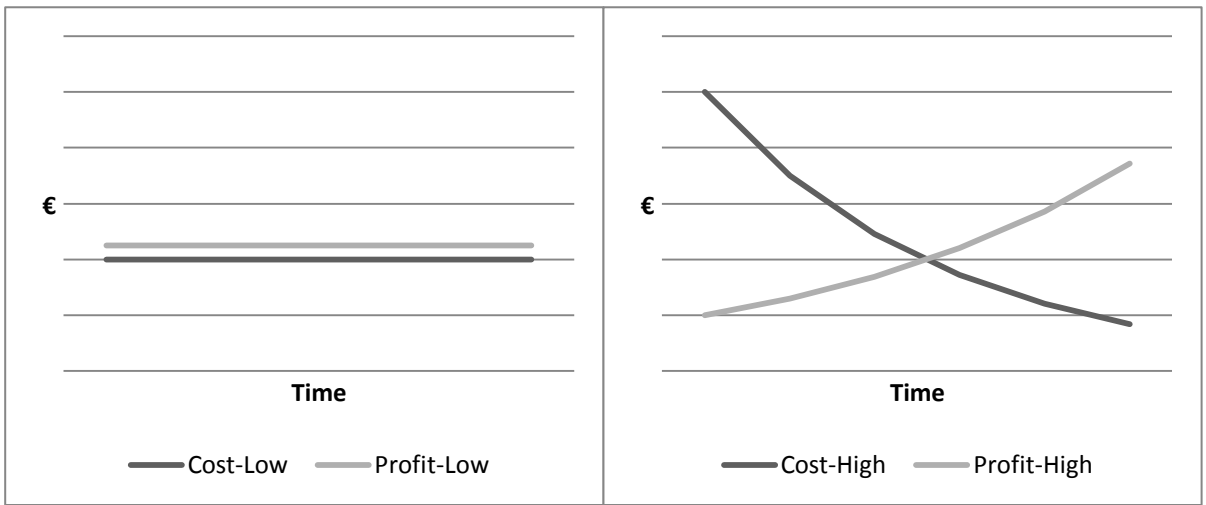


Figure 6, Costs vs. profits, low- and high-involvement relationships.

2.7.3. Economic consequences

The economic consequences are difficult to evaluate and should not only be evaluated from the product and service content (Gadde & Håkansson, 2001). There are numerous solutions, technical and organizational, that affect the costs as well as the benefits.

As Gadde & Håkansson (2001) describe associated relationship costs, they include direct procurement costs, direct transaction costs, relationship handling costs and supply handling costs. When performing a transaction, there are most certainly other costs involved besides the direct procurement costs, i.e. time and money spent during negotiations etc. There are also costs that can only be related to a specific supplier but not the specific transaction, for example when a relationship requires adaption and other kinds of investments in order to gain access to the supplier. (Gadde & Håkansson, 2001)

There can also be benefits related to relationships, both cost and revenue streams may be beneficial for the companies. The problems evaluating this, however, can be even greater with potentially large costs to identify them. (Gadde & Håkansson, 2001)

2.7.4. Structural power and balance

Even if a relationship can evolve over time and by doing so, is strengthened for both parties involved (Skjoett-Larsen, Schary, Mikkola, & Kotzab, 2007), it does not mean it will change the balance of the relationship. Due to the inert nature of relationships, it is usually set early on in its history what position each party will have, a balance that is difficult to shift (Walker, Kogut, & Shan, 1997). Even the social capital can be associated with constraints and outdated commitments leading to impeded competition and lack of change.

A network has a profound power structure where different individuals can contribute as well as influence other actors. This power structure sets the stage for how each party defines its strategies in this specific organization. It has to do with how they perceive themselves and how others perceive their role in the relationship. Because of this, social networks will form between the parties where informal cooperation occurs that become invisible assets to both companies. Without the need to go through formal channels, problems can be worked out by direct communication, providing a benefit that is hard

to match by a competitive company. Even though it is informal dealings with a collaborator, it is something that needs to be noted when considering ex ante costs vs. ex post costs which is the cost of searching for, evaluating and negotiating with new suppliers vs. the cost of enforcing agreements and solving disputes with current suppliers (Skjoett-Larsen, Schary, Mikkola, & Kotzab, 2007). As mentioned earlier, control is important in a relationship which includes the power structure but also the power balance between parties.

Power is an ever present phenomenon, even if some may think it is not and that it will be counter-productive for the relationship, something which is not proven (Hingley, 2005). Abusing the power is very much a destructive path for a relationship but due to size differences in some relationships, exercising one's power can increase efficiency and happens on a regular basis through punitive action or functional conflict. Even with a large size and power difference, it can still be profitable to engage in business between two parties. Some find it more comfortable to do business with larger actors, with the stability they bring, even if it sometimes comes with a certain degree of rigidness. Dependent on the product, the distributor or customer can find it more preferable to deal with an actor that does not have too much power on the market and can get to a position where they can put leverage on the buying party (Hingley, 2001).

The number of actors on a market can also change the use of power as a market with few actors is more dependent on mutual trust and can likely not survive if some actors are overlooked (Dapiran & Hogarth-Scott, 2003). What was earlier seen as power demonstrations can now, with high involvement relationships, simply be seen as a joint decision by two partners.

2.7.5. Trust

Even with quite clear power imbalances, two companies can work together seamlessly if there is a common sense of trust between them. Many definitions of trust exist depending on the perspective, which can vary from psychological and sociological to anthropological and economic (Skjoett-Larsen, Schary, Mikkola, & Kotzab, 2007). Of the mentioned definitions there is one especially that is interesting, coming from Mika Sako, where it consists of three conceptions of trust: contractual, competence and goodwill trust.

Larger organizations tend to shy away from all things related to risks and uncertainty, but for one actor to uphold their part of a contract a contractual trust exists (Sako, 1992). Even if a partner is willing to fulfill a contract, they may lack the resources or competence to do so according to set standards and time limits. This is associated with competence trust and is common in ship-to-stock setups where the supplier is responsible for the quality and delivers straight to the buyer's assembly line. Finally a third type of trust can be present, namely goodwill trust, which is a mutual commitment and expectation between parties. This is the ability to take initiatives in a way of not gaining advantages towards the buyer. If there is a tendency towards opportunistic behavior, this trust will decay rapidly. A goodwill trust can grow over time and increase the involvement between actors giving both parties advantages, if they share principles of fairness and are willing to put in the necessary time (Sako, 1992).

This requires both formal and informal relations but a risk can come from too many informal relations that rely on individuals that can for various reasons leave the company and bring down the relationship that has been built (Skjoett-Larsen, Schary, Mikkola, & Kotzab, 2007). To counter this, a mix of formal and informal relations is preferred but in the startup, formal contacts are more common when the trust between parties has not yet been developed.

Having a supply chain where there is a profound sense of trust between actors can increase their willingness to make things work even if it is not the most beneficial act for oneself each transaction, and provide a basis for increased flexibility for all involved. This will create lock-in effects with the current actors but also bring higher value for the customer reducing their need to change provider. (Pandey & Garg, 2009)

2.7.6. Evaluation

In order to fully grasp what situation and supply chain the company is currently in, one must evaluate the partnerships. Kodak, for example, has eight criteria for evaluation in this matter from which they assess the supplier (Gadde & Håkansson, 2001).

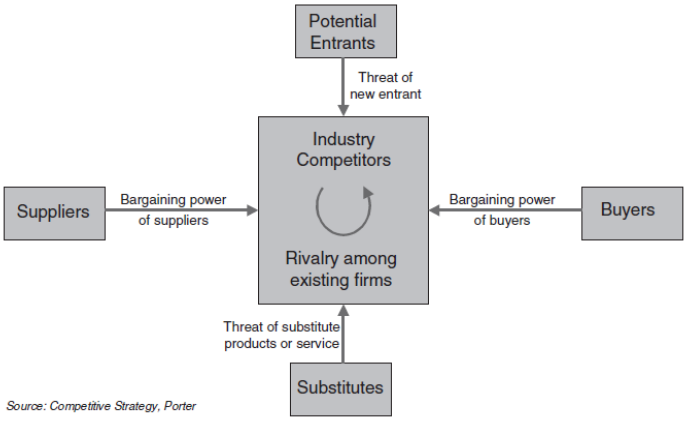
- Amount of technical support
- Number of innovative ideas
- Supplier's ability to communicate effectively on important issues
- Flexibility shown by supplier
- Cycle time, responsiveness and improvements shown
- Supplier identification with Kodak goals; are our goals common?
- Level of trust that exists in dealing with the supplier
- Strength of the relationship at each plant

When supplier performance is unsatisfactory, the buying company can either change supplier or enhance the relationship involvement through discussions, training or assisting the supplier in different ways. (Gadde & Håkansson, 2001) The continuous level of involvement in a relationship must be monitored and adapted in order to gain full benefit from it. Otherwise, there is a risk committing too much or too little and losing opportunities or spending more money than necessary.

2.8. Porter's five forces

The five forces is a model designed to help dominate a market, where the alternative is finding a new market, a so called blue ocean strategy (Burke, van Stel, & Thurik, 2010). Porter's model simplifies the micro-economic theory into five major influences in order to help managers better apply the full contextual thinking. The five forces affect the industry's competition and ultimately determine the profitability of an industry. (Grundy, 2006)

Four forces are actively influencing the fifth force, rivalry among existing firms, see Figure 7. The total of the five forces is



Source: Competitive Strategy, Porter

the primary reason in deciding how the industry competitors are situated related to the industry.

The supplier and buyer power consists of what leverage and bargaining power the actors possess towards the market. For example, if the demand is larger than the supply, the suppliers will then make good profits leading to more suppliers entering the market etc. The model also states that it is a question of how easily new actors enter the market and pose another threat for the existing market actors. There can be entry barriers in the shape of patents, regulations or highly skilled knowledge required. Another force influencing the profitability of the industry is possible substitutes of the product. If a product can be substituted with another product, then the original industry is at risk of losing revenue due to a lack of customers. Finally the existing firms compete among themselves; this rivalry also decides how profitable an industry can become. (Porter, 1980)

Figure 7, Porter's five forces model (Porter, 1980).

2.9. The marketing mix

The marketing mix is a model that contains the four categories that can be controlled by the marketing manager, i.e. address the categories in such a way that perceived value is achieved and the positive customer response increased. It is a way of ensuring that the company can create a successful mix of the right product, sold at the right time, in the right place with the most suitable promotion. (BBC, 2011) This is referred to as the 4 P's of the marketing mix: product, price, place and promotion. (The Times 100, 2011)

The product may be differentiated depending on the industry. The term refers to both the physical products as well as the service, i.e. what is offered to the customer. This might include brand name as well as warranty and quality. There can be different pricing strategies that affect the price as well as bundling and seasonal pricing to just mention a few. A higher price can alter the perceived value in different directions since the customer may relate the price paid to the quality expected.

Place consists of the point where the product is made available to the customers (BBC, 2011). Decisions affecting the place concern for example how the distribution channels are set up, what transportation is used as well as how the warehousing and storing is performed. Promoting a product is not only about the advertisement in newspapers and TV but also the promotional strategies and marketing channels used. Even how the product is displayed towards the customer is a large part of the promotion. (The Times 100, 2011)

2.10. Sustainability

Thinking long-term might not be the highest priority for a company that is pressured to deliver and keep shareholders content but as the governments increases the amount of regulations concerning sustainability and, more importantly, the gazing public eye; it cannot be ignored any longer. Many companies have seen this coming and been pro-active, realizing that there are actually costs to cut from introducing eco-efficient solutions and have made this change in the entire supply chain.

The concept of cradle-to-cradle has increased in popularity since Walter Stahel (1976) introduced the economy in loops which is based on the product-life factor. It comes from the concept of cradle-to-grave

which indicated that the responsibility of the product goes all the way to its grave but Stahel insisted that to be truly sustainable the product must use durable goods so it can be returned to the cradle (The Product-Life Institute, 2008). Mr. Stahel moved on to analyze manufacturing on a micro-economic and macro-economic basis from which he could conclude that it saved large amounts of resources when extending the product-life versus manufacturing a new product (Lovins, 2008).

Mr. Stahel's research, now over 30 years ago, has one wondering why more companies have not realized the benefits of eco-efficiency today and made it into more than a statement on their website. Szymankiewicz's (1993) research suggests that companies do not see the potential of implementing environmental policies and that they instead believe it will increase costs. This leads to the perception of a gap in innovations concerning eco-efficiency changes, when companies see it as a necessary evil and not a way of gaining competitive advantage or cutting costs.

2.11. Green transportation

When it comes to the environmental effects from transportation, it is primarily a question of behavior and a lack of environmental awareness during decision making. Transport purchasers need to realize that they can and should put demands on the provider, which will for example give their purchasing of higher Euro class trucks grounds for investments. As so many other problems and origins of waste, it can be solved with better communication and planning. (Naturvårdsverket, 2009) Today's transportation network is built for small frequent delivers with high demands on speed, often overnight deliveries. In many cases this is overdoing it and creating unnecessarily high service levels which should be prevented during the customer's planning, giving the transporter more time to plan for efficiency (Börjesson, 2010). Due to transportation, in many cases, being relatively cheap compared to the products and seen as something that must be done, little attention is paid to it and even less so to the environmental effects of transportation.

2.11.1. Road transportation

It is a market which is easy to enter and consists of a massive amount of small haulers that has driven the prices down towards the fixed costs. Cheap transportation has led to an increased use of immense production sites that can lower the production cost and then distribute goods through central warehouses and other facilities. Using trucks as the chosen transportation mode gives a high degree of flexibility, usually cheaper than the alternatives, but at the cost of the environment and society in a perhaps non-obvious way. The biggest reason for choosing road transportation is its ability to deliver goods from the supplier directly to the customer without reloading or any handling (Jonsson & Mattsson, 2005). As mentioned earlier, transportation has grown rapidly the last 20 years and road transportation is the most expansive mode of transportation.

A large problem with trucks is that the fill rate is so low, only 40-45%, due to short trips leading to them running empty on the way back. An even bigger concern is that it is a negative trend; the utilization of trucks is actually decreasing. This can somewhat be circumvented by larger actors gaining volumes, allowing for better route planning and the means to increase fill rate. One area where the fill rate is moving towards reasonable levels is in bulk transportation, going upwards to 80% (Figure 8). (den Boer, Brouwer, Schroten, & van Essen, 2009)

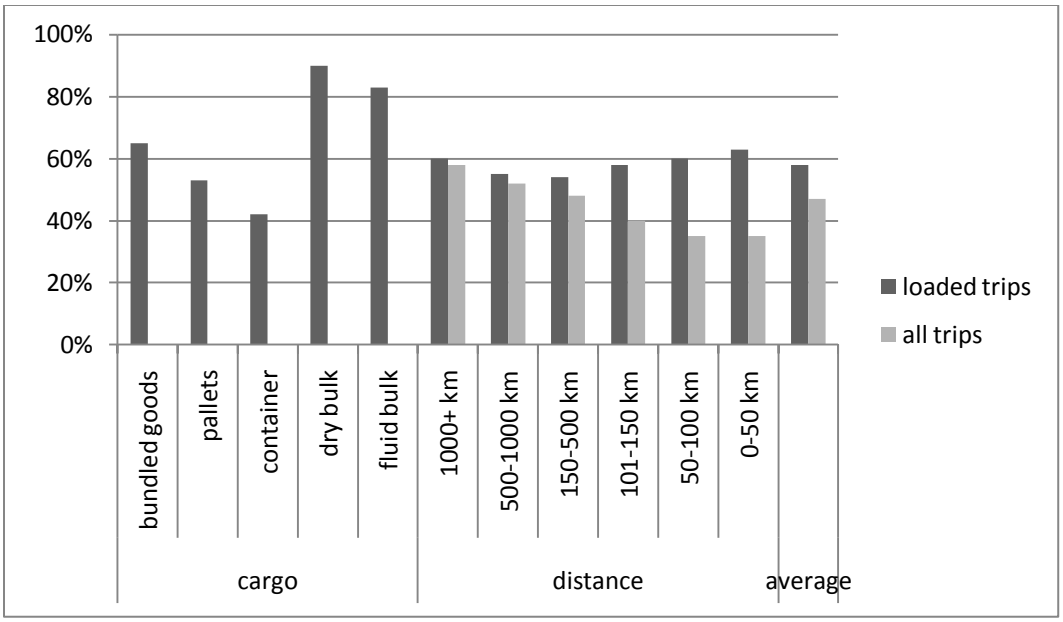


Figure 8, Load and utilization factors in Germany based on ton-km. note: loaded trips do not include empty return trip (den Boer, Brouwer, Schroten, & van Essen, 2009).

Looking at the environmental concerns from road transportation, the biggest worry seems to be the emissions of CO_2, which have not gone down per truck the last years but has decreased when looking at a per ton delivered average (den Boer, Brouwer, Schroten, & van Essen, 2009). Another concern is that the emissions from road transportation contribute to global warming more than for example aviation, not only short term, but also long term (CICERO, 2008). Emissions of the air pollutants NOx, CO and PM (particle matter) have decreased steadily the last 10 years thanks to the euro class regulations dictating steady decline (den Boer, Brouwer, Schroten, & van Essen, 2009).

All these environmental effects are external costs that den Boer et al (2009) try to translate into monetary values. Some are standardized, such as many air pollutions, but effects such as congestion and accidents, valuing human life for example, can be debated. Figure 9 shows a summary of external costs from HGVs (Heavy Goods Vehicles) in the EU. Euro class was mentioned earlier and it is a European classification system that ensures that HGVs are continuously renewed and provides a way for customers to demand certain levels of quality. Local governments have also instituted green zones inside city centres or environmentally sensitive areas that only allow certain high Euro class vehicles to travel in or through. A more international standard is the ISO- certification that more and more haulers are being forced to incorporate to stay competitive on the market, when customers are establishing firm environmental policies.

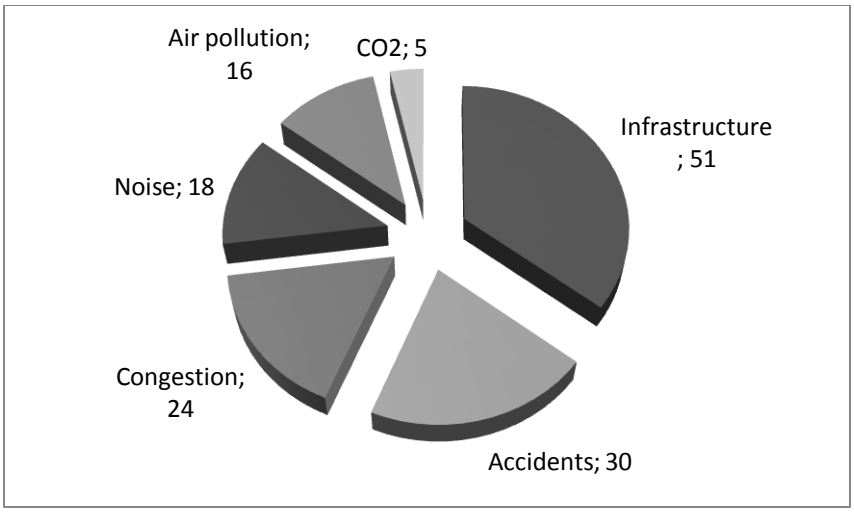


Figure 9, Breakdown of external costs of HGV traffic in EU, numbers in billion Euros. Note: congestion is a rough indication (den Boer, Brouwer, Schroten, & van Essen, 2009).

2.11.2. Railway transportation

Historically, railway transportation has been seen as the long distance, time consuming choice for bulk transportation. Due to extensive load times, its lack of direct delivery to most customers and its limited flexibility, road transportation could grow more rapidly. Railway also consists of an expensive infrastructure but will easily compete with road when it comes to the transportation of heavy goods sent in bulk. The environmental effects of railway are limited, negating many of road transport's harmful effects, such as congestion, air pollution and accidents. In Sweden, the railway is powered exclusively by electricity from hydroelectric power plants, which means the air pollution levels are close to zero. This is not the case for all of Europe where some trains still use diesel locomotives. Rail is still 2-5 times more energy efficient then road, maritime and aviation. (CER & UIC, 2008)

Even with all the positive benefits from railway concerning the environment, the problems with extra loading and re-loading for the goods to reach the customer is still a problem and the fact that it is a more time consuming alternative to trucks (Jonsson & Mattsson, 2005). But with the transport seeing a 25% increase in greenhouse gas emissions in the last 20 years at the same time as all other major industries have gone down (CER & UIC, 2008), something must be done and it can be that railway will make a comeback on the market.

2.12. Dangerous goods

Dangerous goods is a generic term for substances and objects that have such dangerous properties that they can cause damage to people, the environment or property if not handled correctly during transportation. They are divided in classifications depending on their properties, where hydrogen peroxide is classified as 5.1, an oxidizing substance. The notion of dangerous goods transportation does not only include the time the goods are actual moving, but also during loading and unloading as well as all kinds of storage. It does not include shorter transports within the manufacturing facility or the consumer's facility. (MSB, 2010)

To transport hazardous materials by road between countries, one must follow the ADR rules and regulations, which is the European Agreement concerning the International Carriage of Dangerous Goods by Road. Currently 45 countries use this regulation, including Sweden and Norway. The equivalent to ADR for railway transportation is RID, which is also followed in both Sweden and Norway. (MSB, 2010)

When transporting dangerous goods by road, there are limits to what roads one can chose governed by the local authorities in Sweden; Länsstyrelsen. This is done to limit the exposure of sensitive areas if an accident does occur. All drivers transporting dangerous goods must take part in a training course which inform about the dangers, how to avoid them and what to do if an accident happens (MSB, 2009).

3. Method

The method chapter describes the process of the problem solving in this thesis. It contains information regarding how the information was collected as well as what selections and decisions that have been made regarding the manner in which the thesis is done. It first describes the process and then clarifies specific aspects such as the reliability and validity of the thesis.

3.1. Process

The thesis has been divided into several smaller activities such as background, literature review and analysis, thus simplifying both the writing process as well as the reading. The thesis started with a general discussion, both with and without Eka's involvement in order to fully grasp the problems at hand and understand the entire concept and implications related to the suggested thesis. It was Eka themselves who suggested the thesis subject and presented the problems from their point of view. This made the initial phase easier since it was a predefined problem as well as a direct need for the outcome.

After the general discussions and clarifications of the problem the background had to be looked in to. In order to better understand the situation and the context, the background is an important cornerstone and this was achieved through interviews, internal documents and external industry articles.

The literature review and empirical framework were in many ways conducted in parallel. This was chosen due to the possibility of related activities and theories more closely linked to the empirical data and therefore a context that is more put together. This also helped putting things in perspective and simplified the innovative process. The interviews were conducted at the same time as relevant knowledge was gained through literature and articles relevant to the topic.

Following the empirical framework is the analysis which features the areas identified for improvement and the proposed changes to these. The discussion completes the process and is the argument for the recommendations to Eka and its supply chain.

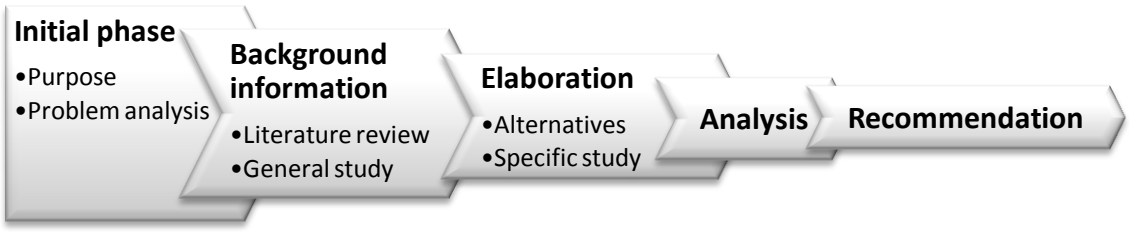


Figure 10, Process flow of the thesis.

As seen in Figure 10 the process has overlapped between the different phases and parallel work was involved at several occasions. The initial phase included both setting the purpose as well as analyzing the problems. During the collection of background information, both the literature review as well as the general empirical study was performed as mentioned previously.

There have been no evident roles for the thesis authors throughout the process, such as document administrator or coordinator. Instead, communication has been a cornerstone in the process requiring full attention and also an open mind to the different opinions. Since it only involves two authors this was chosen since it is important to get two views on every matter throughout the entire process. It also helped to gain a more common understanding of every part of the thesis.

The work has mostly been done at Eka's site in Bohus, north of Gothenburg, but also at Chalmers University on a regular basis. This was chosen in order to come closer to the organization and the problem at hand; with a more direct communication channel to the people involved, the process could become more effective and also better in terms of quality desired by Eka.

3.2. Methodological limitations and consequences

Since the literature review was chosen to be performed, in many ways, parallel alongside with the empirical framework, the total outcome may have been improved. With the ability to easily reject or proceed with any findings as well as controlling the literature according to the current situation is something that has been a key factor to present relevant literature and data. This process obviously requires more time and attention from the authors but was a choice in order to obtain the best results.

The number of actors involved in the thesis was fixed since the supply chain is closely linked and related to each other. However, Eka deals primarily with the transporter and the distributor and therefore they are included in the actors chosen to be more closely analyzed in the thesis. The fish farmers and the operators of the fish carriers have been monitored but are not the subject of a more in-depth analysis. The persons interviewed during the process are all related to the topic at hand and both internal, Eka, and external, the distributor and the hauler, were interviewed mainly to get information regarding the current situation and the upcoming future. All interviewees have been connected first hand to the problems to be able to rely on as precise and correct information as possible.

3.3. Choice of research approach

The data have been collected in qualitative form, mostly through interviews. Through the interviews, the thesis will gain primary data which will be compared with external sources such as industry magazines, articles and government websites. Through this, the thesis gains in-depth knowledge and understanding of the current situation and the market. The different attitudes and experiences will be prioritized among the data in order to meet the identified challenges.

There are certain risks connected to this chosen interview method such as the response in questions due to the interviewers' intonation or body language when asking the questions as well as during the entire interview. It is also a sense of state of mind and the attitude towards each other and between the interviewers. If the interviewee is feeling uncomfortable there is an apparent risk of impairing the quality of the interview. The interview is not a tool but an encounter (Schostak, 2005) and should be treated accordingly. Schostak (2005) also states the fact that the discussion and therefore the differences between the parties that is the heart of the interview.

The thesis outcome is partly deductive in the sense that models are presented from general definitions and principles, but also partly inductive due to the use of models and information given by Eka. A consequence of the chosen approach is that the thesis does not present any statistical results regarding the different results or outcomes.

This report is performed using a case study which according to (Yin, 1994) is *"an empirical inquiry that investigates a contemporary phenomenon within its real-life context"*. In this context the case problem studied have been studied solely instead of several similar problems. This increases the analytical aspects of the problem at the expense of the statistical aspects meaning that the sole problem will get a more in-depth analysis when only focusing on the problem at hand. Hence, there is no room studying several issues in order to ensure the statistical value.

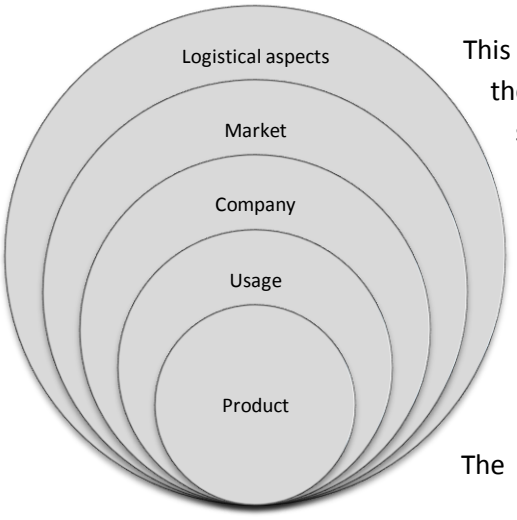
3.4. Selections

The selection within the thesis concerns only the literature review since the different actors involved was a pre-requisite and not a selection, as they were involved in the matter and therefore obvious to interview. The literature review is a reflection of the largest problems in the thesis. There are infinite possible problems to the thesis but there had to be certain limitations in order to elevate the quality and relevance.

Much focus has been spent on the supply chain theories such as relationships and also market structures because these are key factors in the discovered problems. Other selections regarding the literature review have all been done alongside with the empirical framework and conceptualization of the problem.

3.5. Collection of information

The information always serves as a basis for the results, and so it is also in this case. The information in the thesis is collected from both literature and interviews. During the process of collecting information the first priority was to gather knowledge of the product and the usability of the same. This priority was made due to the fact that it was a natural learning curve to first understand the product and company which the report would consider.



This was followed by the information and in-depth knowledge of the market and especially the logistical aspects of the current state. In order to have a clear focus on what information to collect, the priorities made were from the point of the product as it is closely linked to the core of the report and its outcome.

Figure 11, The product information is at the core of the surrounding knowledge areas.

3.5.1. Literature

The literature used is primarily from books and articles used

previously during courses at Chalmers University of Technology and found via Chalmers' library. These are, mostly, in the field of logistics, supply chain management and environmental aspects.

The information regarding Eka, its' competitors and the relevant markets have generally been found through public sources. Some information is internal documents from Eka or AkzoNobel, this information has been verified, when possible, with external sources.

3.5.2. Interviews

Interviews have been conducted with twelve persons within the supply chain, nine of these are from inside Eka. These have been performed by both authors, in most cases, in order to ensure the quality of the interview and gain a better understanding of the opinions and shared information (Lantz, 2007). By dividing the responsibilities during the interview, the authors could focus more on their specific task.

The interviews were performed as discussions to get a better qualitative depth in the information as well as more easily gain hidden information that the authors did not know existed (Schostak, 2005).

We chose to perform face-to-face interviews in all cases in order to gain a higher quality and especially to increase the opportunity for follow-up questions and by coordinating the responsibilities with each other as much as possible this could be enhanced even further (Trost, 2005). There is a risk, however, that the answers are not as well thought out as they could have been if using, for example, e-mail as basis for the interview. When writing the answers the interviewee automatically gets a second chance to reflect and consider what to respond but in a face-to-face interview the body language along with follow-up questions and explanations are more beneficial.

With mostly open-ended questions the interviewee could without difficulties discuss relevant topics in the specific matter. Along with the fact that both authors were present and could ask follow-up questions the quality of the interview could be guaranteed. The interviews were also half-structured in order to gain full momentum of the discussions and interviews. A half structured interview consists of follow-up questions after the structured ones and can therefore be modified depending on the subjects' answers (Lantz, 2007).

The responses given to the authors during the interviews may be biased due to the different experiences and background each subject has. Subjective answers may be given, even though not intentionally. Hence, an ideographic approach must be used. (Lantz, 2007)

There were also follow-up interviews when necessary and possible, because of the possibility of testing ideas and double-checking the information given at previous occasions.

3.6. Reliability and validity

Regarding the validity, the thesis can only be applicable to this specific product and company and is therefore not valid for other companies, but can most likely be used for other supply chains inside Eka that deal with the same product. The factors in this study are so specific to the supply chain that results

cannot be translated into other situations without changing these factors, even if many of the improvements found are to be applied for most segments. It was not the intention to be able to apply the results in another company due to the fact that Eka themselves requested this specific situation to be looked into. Some parts are obviously applicable as well as the combined theory, but every new situation should be looked at from its specific perspective.

The reliability of the study is fairly good. There has been a lot of focus on determining what information is needed for the thesis and double-checking facts and opinions when possible. The likelihood of reaching the same outcome in another study of the same problem is high. The reliability has also been strengthened through several interviews where both authors took part in order to certify a common interpretation of the information given. In order to clarify some information or questions, follow-up interviews were performed, increasing the reliability even further. The reliability may have been lowered in external interviews where the interviewers may have been seen as employees of Eka.

The interviewees have also been asked to review their statements used in the thesis in order to ensure that the information is correct and reliable.

4. Empirical findings

The empirical findings in this thesis describe the present situation for Eka. This is primarily done from an outside perspective to ensure the best possible outcome. With the theory as a reference, the information and data collected can be explored and presented.

4.1. The different flows

The supply chain consists of several different flows, such as physical and monetary flows. These differ since each actor is not part of every flow and the relationship changes between the actors depending on which flow is considered.

4.1.1. The actors

Eka is the producer at the start of the supply chain, when looking at a regular physical flow. They are, by far, the largest actor in the chain and the focal company of this thesis, meaning they become the center when alternatives are considered.

The hauler provides a transport service to Eka. They are stationed in Norway, close to Eka's site in Rjukan, and transport Eka's entire production of HP in Rjukan to customers in Norway. They are a relatively small company with only a few employees and a yearly turnover of roughly one million euro. (Finnfirma.no, 2011)

Eka uses a distributor in Norway for the fish farming industry and they are the official connection to the customers. They buy the HP from Eka and sell it to the fish farmers. The distributor distributes the HP to the fish farmers, the users, along the coast of Norway (The distributor, 2009).

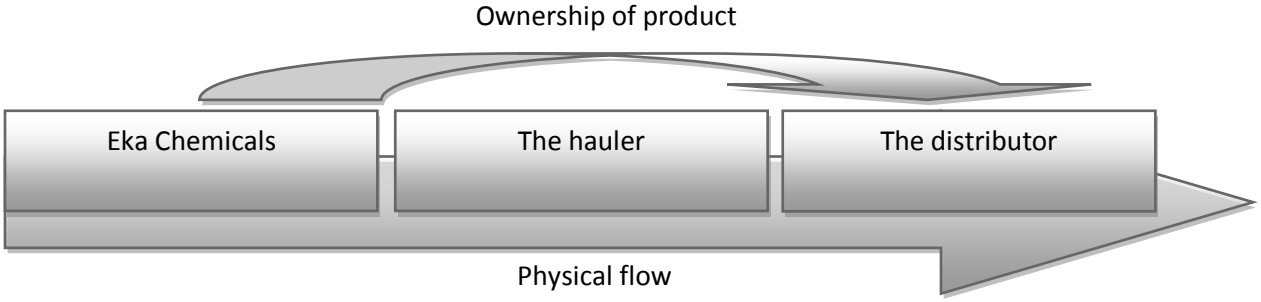


Figure 12, Physical and ownership flows.

4.1.2. Ownership of the product

The ownership of the product changes along the chain. Originally Eka owns the product as they are the ones that produce the hydrogen peroxide and they maintain ownership during transport. The distributor gains ownership when the product is placed at the harbor for distribution to the users. They own the product until it is used at the fish farms. This is due to regulations that designate the HP as a pharmaceutical product in this application and it is therefore only allowed to be owned and handled by a veterinarian (Larsson, 2011). As this is a short ownership chain it supports simplified handling between the concerned actors (Figure 12).

4.1.3. The physical flow

The product is produced by Eka but all handling of the product outside of production is done by the hauler, from the loading at the production site to unloading at the destination. The hauler performs all this for all the delivery locations along the coast of Norway. They are the sole transporters for HP to fish farms in Norway and thereby, they have close contact with the delivery sites in order to meet the users' demands. The hauler then either delivers to the distributor's storage depots or directly to the consumers' boats. The physical flow is similar to Eka's other products but with a more in-depth involvement from the actors. In this case, the hauler is very involved in the process and also has deeper knowledge about the technology used. What differs from Eka's other customers is the fact that there is no dedicated storage facility at the customer site and that the delivery location is often mobile, increasing the complexity.

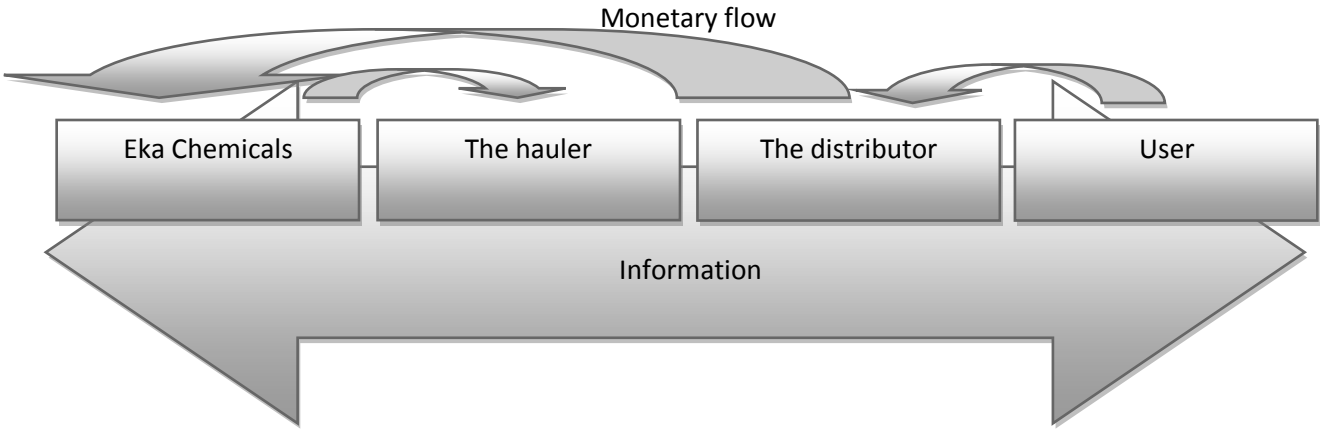


Figure 13, The information flow involving all actors and the specific order of the monetary flow.

4.1.4. The monetary flow

The monetary flow of the chain (Figure 13) is more complex as the users only pay the distributor when the product is used and for the amount that was required. The distributor cannot invoice the users before the product is put to use due to its restrictions as a pharmaceutical product and only the exact amount used can be sold to the users (The distributor, 2009). Eka does, however, send the invoice to the distributor when the product leaves the premises. The hauler on the other hand invoices Eka for the services they perform. Eka has found it to be more profitable to work with a few haulers in their other operations and has lowered the total number of haulers used substantially the last few years, which has also been a strategic direction from its owner, AkzoNobel (Himmelmann, 2011).

4.1.5. The information flow

The information flow is essential in this supply chain. It flows in both directions and also between all the actors creating a network of information sharing. Eka both receives and gives information to the distributor as well as the users even though they are not linked directly to them.

The hauler is a hub in the network since they manage the delivery information and are also involved in the usage of the product at the end customer. The entire network is very integrated regarding the information sharing with unclear boundaries of what information belongs to specific actors, making it a

very flexible and agile chain that can respond to fast changes in demand from customers and deliver in a short space of time. The hauler keeps up to date with demand by direct contact with the fish carriers, not only for delivery location but also amounts needed.

Eka has an internal SAP system that can be used by the transporters in order to better receive delivery information and allocation of the product. The orders are entered manually into the system and Eka has a recommendation for orders to be placed five days prior to delivery. However, this system does not seem to work satisfactorily for the hauler in all aspects. It is especially problematic regarding the customs requirements and the system is therefore mostly seen as an obstacle.

4.1.6. The order handling

The order handling is a complex flow within the supply chain. It is not a simple order from user to producers but instead involves everyone in the chain, some more than once.

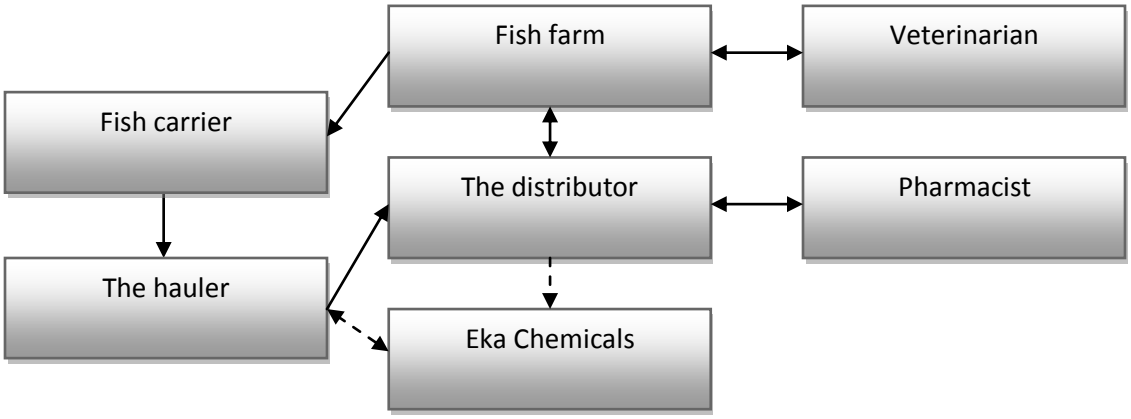


Figure 14, The order chain of hydrogen peroxide from user to producer.

The order starts with the fish farmers having a veterinarian issue a prescription stating how much HP is needed. The prescription is then sent to the distributor which has a pharmacist that approves the prescription's content which is then sent back to the fish farmers. The distributor then sends a gross order to Eka which is not based on the prescriptions but more on forecasting and appreciations of the future market. This order states the maximum amount that could be needed and is often on the upper boundary of what could be needed.

The fish farmer contacts the fish carrier and states how much and when they would like a de-lousing. The fish carrier can then order an amount from the hauler and also give information regarding where it should be delivered. This is often done with just a few days notice if any at all.

It is now up to the hauler to contact Eka to see if there is a valid order. If so, the hauler picks up the HP at one of the sites based on both Eka's preference and the current needs and possibilities of the hauler.

If there is not any order from the distributor at Eka, the distributor must then quickly place an order for the HP to be able to be delivered. This procedure is clearly complex and allows many errors as well as a less efficient supply chain.

4.2. Relations within the Supply Chain

In the existing supply chain, the relations are affected by several activities and structures. The fact that Eka is a much larger actor than both the distributor and the hauler sets the framework for many possibilities but also limitations.

As seen regarding the different flows, such as order handling and information flows, there are many opportunities for the informal communications to take place. This kind of communication between the actors is a large part of the existing relationships. These communication methods are time-demanding compared to other Eka supply chains but are still an important hidden asset which has been used in order to raise the interest of the treatment. The informal communications has vastly improved the flexibility of the supply chain which has been crucial for the outcome of the market, which is also described in the theoretical framework. The hauler has been able to meet the demands from the fish carriers in a better way through the informal network within the supply chain as well as with the distributor being allowed a more flexible approach when it comes to order handling, for example. It has certainly been a key towards creating the existing market but with growing volumes this approach can be a problem.

There are large differences in size among the actors in the supply chain and therefore a more apparent difference in power structure which has not been a problem so far with the common goal of satisfying the demand on the market. Hence, it could even have been an advantage for the actors involved to have a clearer division of responsibilities and labor regarding the activities, which is not something that has been found in this case.

The trust among the actors has been satisfactory from the start. The contractual trust exists simply due to the agreements met and also due to the activities upholding these. The competence trust however can be questioned due to the fact that both the distributor and the hauler might have resource problems if the demand increases but this has not been an issue in the present state. The goodwill trust however, has been solid through well established intentions and proven success.

Through the relationships within the supply chain, one has been able to meet the criterias and demands from the market, allowing the market to expand. This agile supply chain has, through high flexibility and responsiveness, also been successful in positioning the entire supply chain as a solid actor on the market with satisfactory market shares (Pandey & Garg, 2009).

With informal communications being the standard way of communicating within the network there have not been any formal requirements regarding service levels or other measurements. With the possibility of increased volumes there may be difficulties in keeping the informal structure when the supply chain is put to the test further on.

4.3. Internal specifics

The data collected during the process is quite extensive and a selection of this will be presented, depending on relevance and what will be used as the foundation for the analysis.

4.3.1. Production capabilities

As mentioned previously, Eka has three HP production sites in the Nordic countries. Currently Eka wishes to use Alby as the main source of HP for all the customer sites north of Bergen and Rjukan for those in southwest and south Norway. The production volume of each differs and is allocated as follows;

Table 1, Production volumes, percentage of total volume produced.

Production Unit	Alby	Rjukan	Bohus
Produced volume	44.5 %	9.8 %	35.7 %

Using Bohus production site as an example, it is producing 350 days a year with an uptime of around 96% and it can produce 0.1% of the total Nordic production each day. (Staberg, 2011)

The production cost is largely dependent on energy cost and all of the production units use different energy sources; this means different production costs at the different sites. The production is assumed to be running at full utilization in order to calculate example costs without an additional variable. To determine which customers will receive product from each production site, Eka has a planning tool called WhatsBest. This will take into consideration factors such as freight costs and production costs.

4.3.2. Storage facilities

As the product is delivered in different concentrations to the customers, separated storage facilities are needed and the Bohus production site has nine in total. It is a combination of 500 m^3 and 200 m^3 storage tanks which are necessary in order to always have the right product available when a delivery needs to take place. This storage is situated within the factory premises and has connections to both the railway and the transport roads leading out of the production area.

The storage volume is comparable to one week's worth of production. This is mainly because they deliver more then they produce during the weekdays and are then able to build some inventory during the weekends. Most of Eka's customers have their own storage tank which is, depending on agreements, monitored by either Eka or the transporter, keeping it at previously determined levels. This has not been the case with the fish farming industry and instead containers have been used as storage facility, which is quite costly and impractical. However, it does bring a certain degree of flexibility and no need for other investments regarding storage facilities.

The mentioned minor depots have been used as something that is very similar to a split point system where a larger sized carrier can deliver to this split point and then smaller carriers move it forward. This is used in a combination with direct deliveries to the boats which is at this time roughly 60-70% of the deliveries (representative-distributor, 2010). These depots will work as a buffer to keep the service level up, at a cost of the container and the extra handling costs. There are, however, regulations for placing containers in harbors, including specifiying the area they occupy. The depot in Fosnavåg is allowed to have five containers on the wharf and two additional ones about 200 meters further in, creating an otherwise unnecessary need for short distance movement.

4.3.3. Demand

The demand is influenced by two major factors, which are described in the introduction: drastically increasing volume (Figure 15) and the seasonal variation (Figure 16). This shows a doubling of the demand from 2010 to the forecasted numbers of 2011. As this is a treatment with many variables, the exact dosage can differ depending on how bad the lice problem is, making it hard to forecast. Looking at the actual demand for the first few months of 2011, the forecast is accurate in most areas but was distorted in other where the water has been too cold to conduct treatments in. Even so, the demand is expected to catch up and as treatments are moved into the summer months (representative-distributor, 2010).

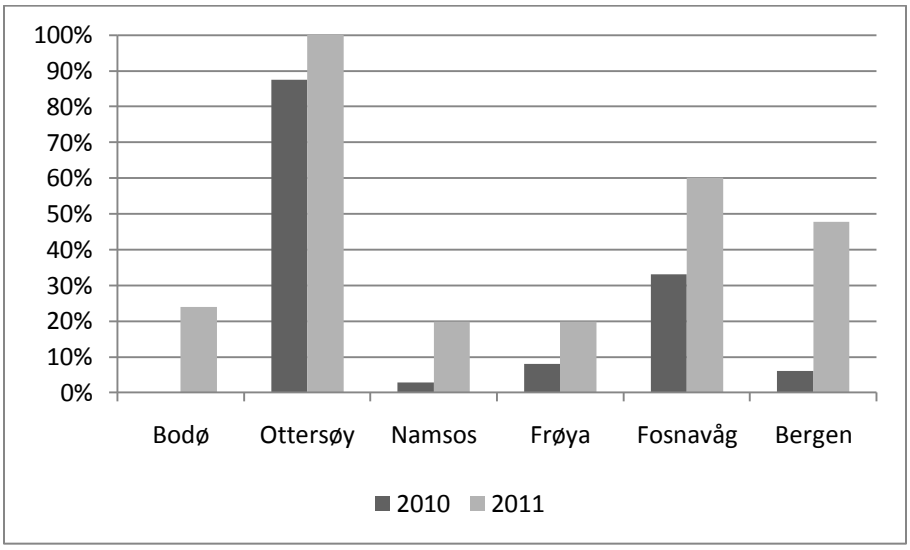


Figure 15, Differences in demand for 2010 and the forecasted values for 2011, indexed by highest volume.

The seasonal variation is due to de-lousing traditionally taken place during the spring because of government regulations. There are also tendencies in the market to even itself out with some fish farmers expressing a wish to do some treatments during the summer. This could perhaps lead to two more separated peaks, allowing for deliveries to be done in the months leading up to the peaks, of course demanding storage facilities if that would end up being the case.

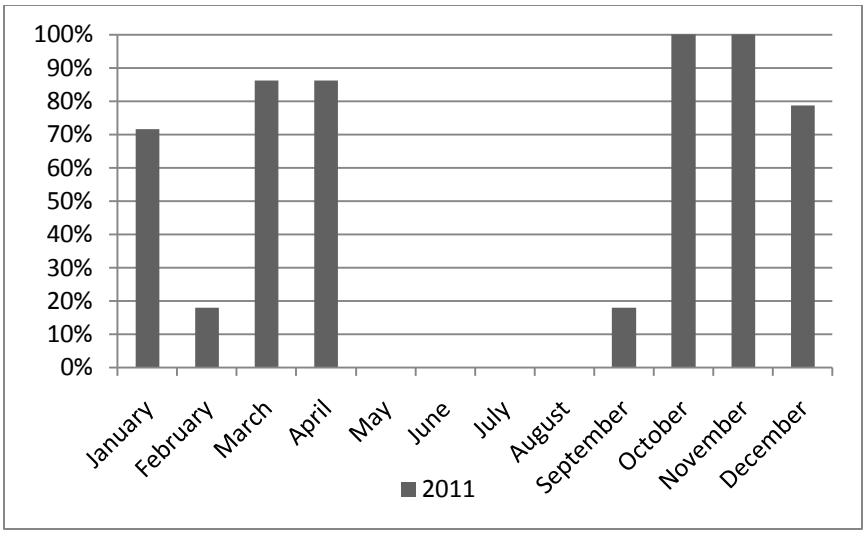


Figure 16, Forecast by Eka to fish farming industry, 2011, indexed by highest volume.

The development in the coming years is hard to predict with such a new market as it is growing rapidly. The biggest salmon grower in the world, Marine Harvest, has a one year deal with the distributor which can indicate that they are not that interested in this method or that they want more options in a fast growing market. A one year deal is not unusual but the fact that Marine Harvest chose to split its supply between two distributors is also a strong indication. It would be preferable for Eka and its collaborators to have the customers commit in some way so that more investments would be viable. No one knows where the market will end up, with some saying this is the peak and others predicting it can grow five to six times still.

4.3.4. Distribution channels

The distribution channels for the hydrogen peroxide are more complex than normal for Eka. Regarding the transportation, only trucks are currently used, either carrying an ISO container or a using tank truck. Eka deals with a distributor in Norway who handles the customer contact and most official dealings in Norway concerning the method and holds the license for selling medical drugs in Norway. (Larsson, 2011) Due to an exclusivity deal with the distributor, no changes in number of distributors can currently be made.

Considering the transportation there are no exclusivity deals but a close partnership has been formed with the hauler who is very involved and a driving force in this project. The hauler is a small actor compared to Eka but has provided a great deal of extra value in the form of unofficial connections and knowledge about local matters. Using only one transporter limits Eka's choice in means of transportation and the alternatives will be discussed later in this chapter. Important factors in this aspect are not only the financial costs but also knowledge and service provided in addition to the transports.

The demand for short lead times from customers has made this distribution channel a complicated network with undefined delivery locations and a daily routine dependent on communication. This issue heavily affects the hauler which is therefore involved in both delivering the product and all the

necessary communications between the actors. They may also be involved in the order handling primarily between the distributor and Eka. The distribution channel is a complex network held together by the heavily involved actors.

4.3.5. Transportation costs

In order to establish the relative amount of the transportation cost, information was provided concerning where the product was delivered from and to which harbor it was delivered to. This, combined with the freight costs that are in the agreement with The hauler and price levels for The distributor, was used to calculate a transportation cost based on revenue (Figure 17). This shows that the transportation cost is between 22 and 38 percentage of the revenue, a large difference depending on the HP sourcing location. This says nothing about the actual volumes being sent to each harbor, which is why Figure 18 is presented. Especially Ottersøy shows a large problem with product going from the non-ideal production site and as it is such large quantities, it does not seem to be the result of last minute orders.

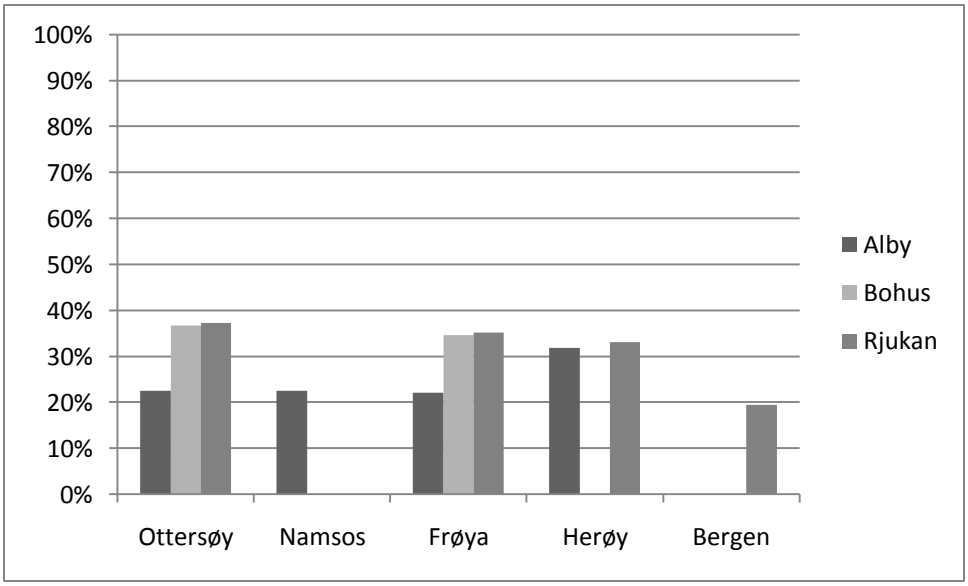


Figure 17, Transportation cost of total revenue for each delivery harbor, 2010.

The freight cost is a fixed price per transport, regardless of what kind of truck is used and how much product it carries. The transports done during 2010 had the following average weights:

Table 2, Average weights for transports during 2010.

Production site	Alby	Rjukan	Bohus	Total
Average weight	29 tons	28.4 tons	27.9 tons	28,4 tons

These numbers would indicate that more tank trucks are being used from Alby and that Rjukan and Bohus most likely had its average lowered by small emergency transports, for which exact data has not been found. Altogether this shows quite clearly where it is most beneficial to deliver the product from,

assuming there was excess product at all production sites. This might not be the case, which is why the program WhatsBest is being used, as it takes all customers and all freight costs, production costs and so on into consideration for all of Eka.

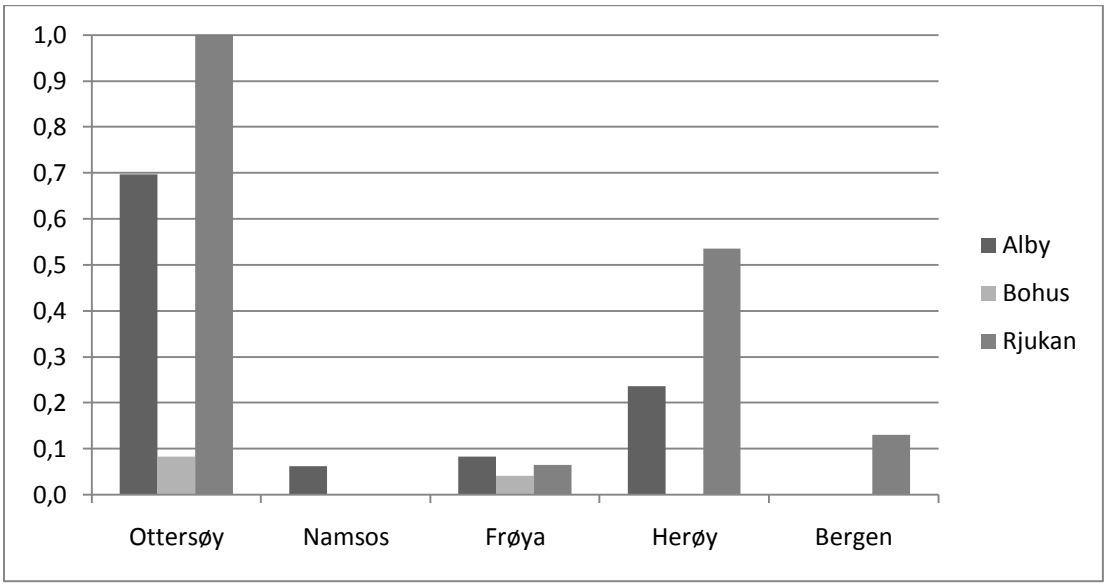


Figure 18, Volumes for each harbor, indexed by largest volume, 2010.

Comparing Eka's transportation costs for the fish farming industry to other customers, in the same region, can give some idea of the size of the transport cost. One does, however, need to keep in mind that the fish farming industry is a special case and that the hauler provides so many extra benefits here. Table 3 shows the freight costs based on distance and size of truck showing that the fish farms are not much more expensive than other HPSA customers (hydrogen peroxide special applications). A large difference compared to a regular paper mill customer is evident and largely based on the volumes being considerably bigger.

Table 3, Indexed freight cost (€ / ton-km). All based on Rjukan as production site.

Customer	Container	Tank truck	Distance (km)
Bergen	61 %	61 %	350
Herøy	100 %	100 %	420
Paper mill	37 %	43 %	180
Other HPSA	76 %	76 %	200

It should be noted that the table is misleading as every transport consists of a variable cost depending on kilometesr and a fixed cost that is divided per kilometer, which would increase if it is a shorter trip. The noteworthy figures are not affected as the lowest cost is presented by the shortest distance. Even the kilometers can be uncertain as special circumstances can affect this for some trips.

4.4. Market situation

4.4.1. The market size

The market size is hard to define as it is dependent on different factors starting with the entire salmon farming industry which is a massive market with an estimate of one million tons during 2010 (Figure 19). The Norwegian salmon growing industry is vast with sales amounting up to 20 billion NOK (Fiskedirektoratet, 2010), making the need for working methods to de-louse an important issue.

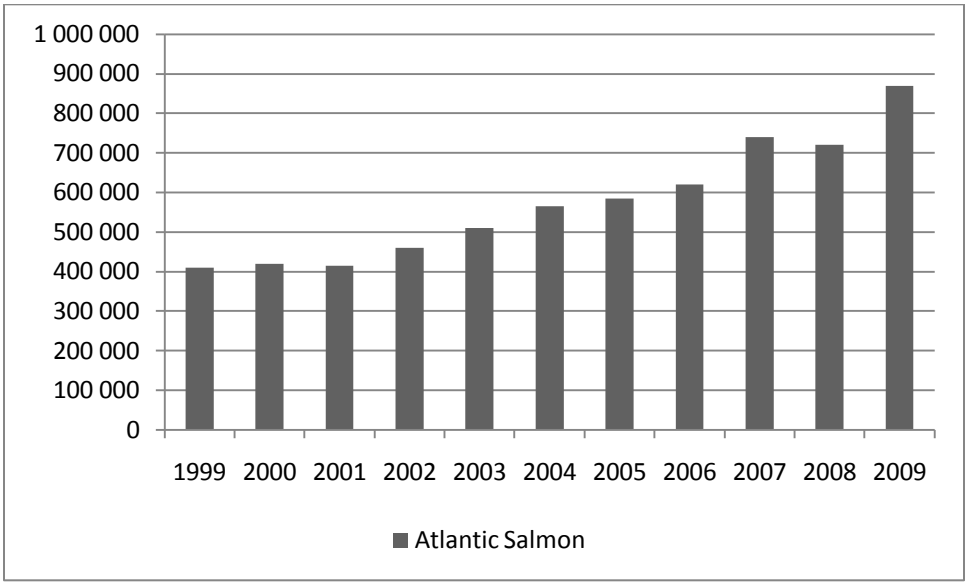


Figure 19, Sale in tons of Atlantic salmon from Norway 1999-2009.

Market growth rate for the fish farming industry has been positive for many years with an exception in 2008 which is most likely due to the global economic crisis. Following the growth trend the last 10 years (Figure 19), there will be an increase of 15-20% in 2010, breaking the 1 million tons of sold salmon (Fiskeridirektoratet, 2010).

The growth cannot continue forever both due to the lice problem (DN.no, 2010) and also the fact that the salmon are fed with other fish that are becoming endangered if this continues. Currently it requires 4 kg of feed to produce 1 kg of salmon (Valestrand, 2008). The main problems with increased lice infestations are that even though the net enclosures are becoming larger and larger, there is less space for each salmon and this increases the lice problem exponentially (DN.no, 2010).

There are however no visible trends of slowing down in the salmon farming industry and they are confident that the lice can be controlled with the proper use of a variety of methods, where hydrogen peroxide is one (DN.no, 2010). During 2010, the total estimated market for hydrogen peroxide was a bit more than 3 thousand tons of solution (Mugaas Jensen, 2011). The current methods for de-lousing are dependent on alternatives to avoid the lice developing resistance towards these substances (Berglind, 2011).

Since the entire fish farming market does not use hydrogen peroxide as their primary de-lousing product the HP market is limited (Larsson, 2011). Although, this leaves possibilities of the HP market to expand further to fish farmers currently not using the method. There are also further sales to be made to the fish farmers already using the HP method, resulting in a good potential market size for HP. One must realize that the market is not likely to keep growing at the same pace for several years. It is a re-emerged market that needs to mature before any exact conclusions can be drawn on where a steady supply will be demanded.

4.4.2. Five Forces

Market profitability can be described by Porter's five forces which make up a framework for this and also map the dependencies between actors. This has been explained in the frame of reference (2.8.) which is the basis for the following section.

4.4.2.1. Supplier power

First off, the supplier power is a force which seems to be large in this particular case. It is a market that requires the product to solve their problem, not only to ensure the salmon is healthy and alive when arriving at its destination but also due to Mattilsynet enforcing limitations on how many lice can be on a salmon in average (Berglind, 2011). If this is not reached after trying different methods of de-lousing it can go as far as the fish farm being forced to slaughter all of its salmon to reach suitable louse levels, which greatly affects the revenue for the fish farmers (Mattilsynet, 2010).

The supply is therefore more important to the buyer than the supplier since this is a side business for most hydrogen peroxide producers and not something they would prioritize over their very large pulp and paper customers. The supplier power is somewhat limited by the uneven demand and even the transportation can be a limiting factor here when the peaks in demand call for high frequency.

4.4.2.2. Buyer power

The buyer power is a bit questionable for this product as the suppliers, such as Eka, need to prepare weeks in advance for the large delivery for the springtime de-lousing. It would be preferable for the hydrogen peroxide producers if the market matured and evened out at a reasonable level. This could also strengthen the buyer power since the supply then would become even more standardized, now in terms of distribution. This could lead to tougher competition among the hydrogen producers.

The fact that the fish farming industry needs to alternate methods speaks in favor of hydrogen peroxide. Even though there are several methods available, the market is so big that the demand will most likely be there unless a new improved method enters the market. The sheer size of the market shows that the buyer power is large; someone will always be after the product. What makes this a limiting factor is the industry's reluctance to sign long term deals with a method they feel requires too much handling, making any investments subject to short pay off times.

As the process requires a large amount of product when using hydrogen peroxide, the location of production becomes important to provide profitability on this, geographically, remote market. This gives Eka an advantage in having a production site in Norway and two others very close. Eka are at the moment the closest supplier by far, leading to fewer possibilities for the buyers on the market since the

distribution is currently complex and therefore favors the production location heavily. This leads to the buyer power being partially diminished in this aspect.

4.4.2.3. Substitute products

As seen in **Error! Not a valid bookmark self-reference.** there are different treatment methods for salmon lice. The main methods are leppefish, biological and medicinal tablets. The leppefish is a specific fish that eats the lice from the salmon, which is environmentally friendly but expensive and difficult handling. The biological products are poured into the water and affect the lice from their surroundings while the medicinal tablets are fed to the salmon, which mean the lice are affected from the salmon instead of the water. (Nygaard, 2010)

Table 4, Different treatment methods against salmon lice (Nygaard, 2010).

Method	Product	Dose
Leppefish	Certain fish that eat the lice	-
Biological	Alpha max	0,2 ml/m^3
	Beta max	0,3 ml/m^3
	Salmosan vet.	0,2 g/m^3
	Hydrogen Peroxide	1,8 kg/m^3
Medicinal tablets	Slice	Min. 50 % of daily food for min. 7 days
	Releeze vet.	Min. 50 % of daily food for min. 14 days
	Ektobann vet.	Included in food for at least 7 days

Substitute products, such as the biological methods, are currently available and more will most likely appear on the market (Berglind, 2011). However, it can be hard to predict since the research is only partly the obstacle towards new methods, the second being getting it approved for use and having all the proper manufacturing licenses. All this is both good and bad from the perspective of the hydrogen peroxide producers since there will always be a demand for several methods, including HP, to avoid the lice developing resistance against any one method. It is bad in terms of the never-ending competition from several different methods and thereby difficulties determining the total possible market.

Regarding substitute products it would be damaging if a new, more easily handled product would enter the market. Especially when handling costs are high and the sheer amounts of hydrogen peroxide needed can be seen as arguments for the fish farmers to use alternative methods. The HP itself only makes up 10% of the cost for the treatment (representative-distributor, 2010). However, the buyer power is, as mentioned, a limiting factor for the sales of HP as the fish farmers, if given a choice, would prefer other alternatives over hydrogen peroxide.

Even though research is being done in this area, it is unlikely that an alternative will appear on the market in the next few years. It is a long process to develop, test and new treatments approved, especially as it is dealing with a medical product and the rigorous scrutiny this brings (Mattilsynet, 2010). This includes how the method affects the salmon, the consumer of the salmon and the ocean in which

the treatment takes place, both direct problems and long term effects, making it a very complex process.

The current method of treatment in the fish carriers may be phased out in favor of direct treatment in the net enclosures. This would eliminate the need for using the very expensive fish carriers but would require more hydrogen peroxide per ton salmon. (Berglind, 2011) The treatment could suffer in terms of effectiveness but this is something that could be avoided by more tests and new equipment. Problems include being more weather dependent and having to move the net enclosure which is being used as a treatment facility. There is also research being done on combining the use of HP with rinsing the fish with water, something that is lethal with too high water pressure, but could be successful if it allows for HP to remove 80% of the lice and water rinsing to remove the last 20%. (representative-distributor, 2010)

4.4.2.1. Potential entrants

New entrants into the market are not that likely at the moment. Even though the hydrogen peroxide as a product is standardized and does not differ in quality among producers, there are heavy investments required in order to start producing HP. Existing producers could more easily enter the market, but a high knowledge level is required in terms of local knowledge as well as buyer connections. Since it is a highly standardized product, the producers must instead provide additional benefits to the fish carrier vessels and focus must be on the accuracy and precision connected to the logistics. The existing producers could enter the market merely as a supplier and by doing so avoid the need for local knowledge.

It is necessary for the producers to have a license to produce and sell medical products in Norway, but an exception has been given to the distributors as this was such a new area for the product. These will however stop being valid as soon as one producer is granted a full license. Applying for this license also gives an early indication of when competitors are moving in on the market. (Larsson, 2011)

4.4.2.1. Rivalry

The current competition between the suppliers is not a burden at this point since the market is growing faster than the producers can distribute. However, the rivalry can increase when the market matures and the actor's positions in the market become clearer. Currently the biggest limitation on this market is the lack of fish carriers, creating some rivalry between distributors on who signs deals with the boats first. There will also be some rivalry between treatment methods as they need to show the highest possible survivability of salmon, while at the same time removing as much as possible of the lice.

4.4.3. Expanding the market

Expanding the market to other countries is not of interest at the moment as it is in Norway that Eka has been active due to the closeness to its plants. This could be of future interest for Eka and its production sites when the Norwegian market has matured but would need a more strategic approach after Eka has gained more knowledge and experience regarding the possible outcomes.

The domestic market in Norway is still far from exploited and the growth possibilities are immense if no limitations from the supply side were impacting it. The current customers that the distributor deals with

do not solely use HP as their treatment for lice and there are even more customers that have not even tried the treatment. But as mentioned previously it is not realistic to look at the entire market as a potential market, simply due to the sheer size of it.

The problem with increasing the customer base is that they are very spread out along the coast and that it can limit the economies of scale that increasing the volumes should bring. This can make it more beneficial to center one's customers and focus on a special area of the coast, at least in an initial phase to see the progression and then evaluate this before expanding.

4.5. Alternatives in transportation

4.5.1. Railway

As railway is currently used by some of its customers, Eka has the know-how as well as existing handling equipment but the railway infrastructure in Norway is limited, especially close to the coast, where all the customers in the fish farming industry are located. If the train cannot deliver straight to the customer, a reloading will need to take place, adding large handling costs and delaying the transport. There have been internal discussions in Eka about using railway for their Norwegian customers but the low volumes and the fact that the shortest route from Alby is not fully electrified ended the discussion. Currently the Swedish railway system is 100% electrified but the route between Storlien and Trondheim is not, creating a need for changing engines.

Even with a diesel engine, train is the best alternative from an environmental aspect. Train is also well adapted for bulk deliveries because it can carry heavy goods to a much greater extent than road transportation due to the weight restrictions. Railway freight has gone through some increases in price in recent years - for example Green Cargo raised their prices by 7% during 2010 (Rahmquist, 2011a). This along with the fact that there are few actors in the railway market, enabling risks for lock in effects to a much further extent, creates difficulties in both flexibility and power towards the transporter.

From the Bohus production site, which has a direct connection to the railway system, the delivery would either go through a central hub or through dropping off the container when the destination is reached. Since Eka has no possibility to control their own deliveries via the railway system, a transporter must be used. This transporter must then allow for wagon loads, which is not currently an option within Norway. When shipping from the Alby production site, the distance is much shorter to its final destination, especially for the northern customers and the current hub in Rørvik. The short distance is a disadvantage due to railway transports not being as dependent on the distances since the large costs arise within handling rather than from fuel and personnel costs.

Eka has past experience of railway deliveries in Norway with a chlorate factory in northern Norway but it got increasingly difficult to use single wagon loads and they moved more and more towards using containers on railway before finally closing the factory. The single wagon loads increased in price and required more administration, which was an effort from the operators (i.e. CargoNet in Norway and Green Cargo in Sweden) to discourage it. (Rahmquist, 2011b) In order to use tank wagons in Norway it would be required to justify its own engine for the train. More and more containers are being used on railway today, consolidating in terminals and redistributing before the next trip.

4.5.2. Road transport by container

Eka currently deals with a lot of containers, both for storing capabilities and also transportation. This is used from all three production sites and is a well-established system within Eka and its supply chain. Even though used heavily, Eka has no equipment for internal handling of the containers. This means that containers cannot be loaded and unloaded at the sites in order to be stored or the to make the system more effective. A container provides flexibility and the option of storage on site, although expensive, but is low volume per transport compared to using a tanker truck. The container supply is limited and has a long delivery time which creates a static framework of the container system.

The deliveries of hydrogen peroxide are always done in full truck loads straight from the production site to the end customer for non-fish farming customers. As they all have fixed storage tanks and the time frame is less of an issue the transportation can be planned well in advance. It is still in full truck loads, no matter if it is ISO-container or tank truck.

The principle of how to use containers is simple. They arrive on a truck which is filled by the hauler at the production sites, and there is then the possibility of using intermodal transport means or simply to use a direct delivery either to the customer, to a storage tank, or to a specific destination. The method is the same for all production sites which standardizes the handling for both Eka and for the transporter, which can then pick up the product independently of the site.

The system is flexible with small volumes and low tied up capital but, because of this, is also not efficient and has no economies of scale compared to many other alternatives. The environmental effect is unfriendly, combined with the exhaust and increased congestion, noise and barriers. It is, as of today, not a sustainable option due to its dependency on fossil fuels but it has several upsides such as short response times as well as a competitive market for the transporter.

4.5.3. Road transport by tanker truck

Just as with the road transport by container, this is also currently used at the different production sites within Eka. All in all it is the same mode of transportation as road transport by container but has a few other characteristics. One limitation with using a tanker truck compared to container is that the tanker truck needs to be present when the ship arrives in the harbor. The container can simply be left there and the driver of the truck can plan his rest-time accordingly. (representative-distributor, 2010)

The volume is larger compared to using containers but much smaller compared to the other transport modes. There is of course a loss of flexibility when the tank cannot be left behind and used as a storage option similar to the container. Instead, the truck is tied up as long as it holds the product. It is also less flexible due to the lack of intermodal transportation adaptations, in order to be used in an intermodal transport system. The product must be unloaded into another storage option during parts of the journey. If this is done, requirements for handling hydrogen peroxide must be followed and there is the need forspecific facilities and supervision, etc.

It is, however, a more effective use of road transport since it transports a larger volume of product each time and limits the need for, and thereby the costs for, containers.

4.5.4. Air freight

When using air freight, the possible option is from an airport close to the production sites in Sweden to an airport close to the final destination in Norway. The product must be delivered from the destination airport by truck to the final destination where it is stored in the transportation container or in a stationary container at the destination.

There are several limitations that apply in this option such as only 40% soluble solution is allowed for air freight which of course is problematic when the users demand a solution that is close to 50% soluble solution (Eka Chemicals, 1997). This would either mean increased volumes as well as another production process after the transport or it would mean revising the entire method to adapt it to the lower concentration.

There is also the reality that air freight would minimize or remove the usage of tanker trucks and instead require containers adapted to the handling equipment for air freight. Since air freight is mostly associated with high value merchandise and not bulk commodity it would be an unusual choice of transport mode which also increases the environmental effect from transportation. The positive effects with air freight in this matter would be short delivery times and could therefore lead to less tied up capital.

4.5.5. Sea freight

Sea freight is only reasonable from the Bohus production site due to the distances to the ocean from the other two sites and includes unreasonable detours. This makes the alternative irrelevant in most cases since Eka currently prefers deliveries from the sites in Rjukan and Alby.

If this situation changes, it would be somewhat beneficial to arrange a milk run with a large tanker that originates from the Bohus site. This would require necessary volumes in order to make it profitable as well as ports or other unloading spots available for not only the freight vessel but also the fish carriers.

This alternative would result in tremendous tied up capital in terms of the storage of the product until the freight vessel are filled above a minimum break-even point. There are also significant costs for the freight vessel making it an extremely expensive mode of transportation since the freight vessel would be in the harbor for a long period of time while being filled.

This alternative is, however, relatively environmental friendly and can handle, and supports, large volumes. Unfortunately these specifics also make this alternative very inflexible and it would have a hard time meeting the criteria set by the market.

4.6. Current environmental work

Eka follows AkzoNobel's overall environmental goals and consider sustainability to be a cornerstone of the company. Therefore the environmental aspects should be a part of the everyday work and something that is naturally given consideration in every major decision within the organization.

Eka have yearly environmental reporting demands established for their transporters. They have for example general environmental goals for the transporters which are discussed quarterly with the transporters during the original meetings. There are four general goals which are:

1. Climate target and mitigation plan

- All carriers should have a climate target and a mitigation plan for achieving their target. The target can for example be achieved with fuel reductions, use of alternative fuels or increased use of train or ship.

2. Euro class

- In 2011 the lowest Euro class level acceptable for transport performed for AkzoNobel will be Euro class 5. Exceptions can be made if a development plan for the upgrading of the fleet is presented.

3. Eco-driving education

- Regular training in Eco-driving or BBS (where Eco-driving is one part) is mandatory for ALL drivers.

4. Regular monitoring

- All carriers should have a monitoring system for operations and maintenance of the fleet (fuel consumption, tires, oil, etc.).

AkzoNobel do follow-ups of the environmental performance of the transporters based on these goals and also uses follow-up measures in order to better align with the general goals.

The hauler is performing well in the overall environmental performance. They are not one of the leading transporters but far from being at risk of getting replaced based on the environmental aspects. They are doing quite well for all of the specified goals but with general comments that AkzoNobel suggests that they should be more specific and develop clear targets and plans in their environmental work.

AkzoNobel has general ambitions with their environmental work such as reducing the carbon footprint, in terms of cradle-to-gate, by 20-25 % in 2020. This will obviously affect all transporters and put more demands on them regarding, for example, use of Euro class 5 and 6 trucks.

The hauler is set to meet the requirements of only using trucks classified as Euro class 5 by 2011. They do not have a large fleet of trucks but are committed to upgrading continuously and thereby doing what is needed in order to reach the general goals.

4.7. Dangerous goods

Dealing with a dangerous goods classified product provides no real problems for Eka as long as it is considered early on and planned for. It does limit the concentration levels allowed for road transportation and even more so for air freight. The real problems occur in the handling, especially

when re-loading between storage facilities as this is the biggest risk concerning spillage and contamination. Drivers need to be educated in dealing with hydrogen peroxide specifically (Staberg, 2011) as well as have ADR certification to transport it.

A vessel needs to be authorized for transporting hydrogen peroxide but the same rules do not apply for the vessel when it is used as treatment vessel, meaning the fish carriers get around the rules this way. This could, however, prove to be a problem for transportation of hydrogen peroxide to the stationary fish enclosures and doing treatment directly in them.

5. Analysis

The analysis will be based on eight main areas which all have different focus and thereby give different views on the subject. The challenges are chosen from the original problem description given to us by Eka and also on the problems found to be somewhat of a foundation for the overall problems. Every area will describe the related problem along with the desired long term goals, considered to be 5-10 years in the future. These long term goals have been discussed and reviewed by Eka. After this, the proposed changes are described along with indications of the potential savings for Eka.

5.1. Market

5.1.1. Problem description

There is a large uncertainty regarding several aspects of the market. In Section 2.9. the 4Ps (product, price, place and promotion) of the marketing mix were discussed, and these can be applied when analyzing the current and future market.

The product is, as mentioned in the market situation described in Section 0 a commodity and is therefore nothing that Eka can compete with in terms of quality, for example. With the handling costs and costs around the method being rather expensive compared to other methods, the use of HP may be replaced with new methods that appear. It can be methods both using HP as well as other chemicals. New alternatives, however, will not be introduced at the spur of the moment, but instead will be the result of long tests, providing an early indication of the entry of new competing alternatives. The possibility of substitute treatments is to be taken seriously but can be foreseen early on.

The users are not sensitive towards the base price of HP, but rather the treatment as a whole which rules out the price being a competitive advantage towards competitors. There are more negative aspects regarding the use of HP as a method when it comes to the total price of the treatment. The fish farmers have to pay more for this method than other methods with the product price only being a small part of this, one-tenth, leaving the end user fairly uninterested in the price of HP. The key is instead to have a stable and reliable method.

However, the delivery location is most definitely the main aspect for the users. The mobility of the fish carriers performing the treatment is very limited, leaving place as the primary aspect of the four P's. This is problematic due to constant changes in delivery locations and requires a more flexible supply chain because of this even though the location of Eka's plants gives them an upper hand compared to other producers since they are geographically much closer to the end user.

The last P is promotion, which is a significant factor now but is likely to be even more so in the future. It includes both promotion for Eka themselves and for the method itself. With a good reputation as a foundation, Eka will profit from this when the competition from both other methods as well as other HP producers increases. There is also the apparent risk of not knowing when the market growth will stagnate and mature if the promotion is not of interest.

It is important to build a brand in order to keep the customers and thereby secure the future demand. Herein lies the primary problem for Eka and its collaborators, in making the supply chain the competitive factor in the future.

5.1.2. Long term goals

Eka's long term goals are primarily to get a mature and stable market. This will lead to a better possibility for planning, both regarding production and deliveries as well as investments.

The volumes must also be big enough to justify the investments made and the ongoing commitment to the market. The volumes should be large enough both in the total market and also in terms of regional locations supporting investments such as storage. Eka must see the area as profitable even when considering administrative costs and all the extra attention it creates.

Another key issue regarding the market is that Eka will hold a leading position on the market but not be responsible for all of it. This way, Eka does not have responsibilities towards every customer along the Norwegian coast and sets the boundaries and structures by being the market leader.

5.1.3. Proposed changes

In order to gain understanding of the market and be able to predict changes more easily, which is crucial in order to make the correct decisions, Eka will need an overall good reputation. The reputation will allow Eka and its supply chain to stay informed regarding the user's priorities and preferences through a closer relationship and connection to the fish farmers as well as the fish carriers.

The good reputation is important not only for Eka but also for the method itself, keeping and expanding the overall market for hydrogen peroxide. As seen from using Porter's five forces (section 2.8), the competition and rivalry is not of any concern at the moment. However, the substitute products are closely linked to the future success of the HP method. Hence, the promotion (section 2.9) and thereby the reputation is a key factor in order to combine market maturity along with a large volume. Reputation is an important factor regardless of which future scenario one focuses on; it will still be critical in order to both keep and develop the market.

The supplier power must be enlarged by Eka. If they were to put more pressure and demands on the actors within the supply chain, the complex supply chain could be simplified. It is imperative that the demands and pressure are not too much and that it is distributed along the supply chain in order for it to be sustainable in the long term. Through increased demands and regulations, such as order formality, introduced to the transporter and distributor they can more easliy adapt to the future changes as well as put more pressure on the fish carriers and fish farmers.

The buyer power should therefore be reduced in order for the supplier power to be enhanced. It is still important to take these aspects into consideration and not disregard the customer preferences completely. In that case, there is an apparent risk of losing the market. Since the market uncertainties are large and predicting future demand is not within the scope of this thesis, two scenarios will be introduced to deal with this:

- ***Scenario 1:*** The market matures and becomes stable at the level of 2011. This makes it a small overall segment for Eka but still a reasonable size for continuing to operate here. The demand in 2011 is roughly twice that of 2010.
- ***Scenario 2:*** The market has kept growing and is at three times the volumes of 2011. The treatment has most likely been refined and been successful. No other treatments have been introduced onto the market, making it possible for the hydrogen peroxide use to grow.

Both the supplier power and the buyer power will change depending onwhich scenario the future brings. Using scenario 1 the demands and pressure put on the supply chain can push the market into a more volatile state. Considering scenario 2 the supplier power increases automatically and more pressure and demands can be presented with less risk involved.

If Eka is to expand the market, they must simplify much of the process. One possibility is by introducing a more direct customer focus, say for example focusing on dealing with the fish farms that belong to one large actor, such as Marine Harvest. If this proves successful, Eka could focus on larger settlements that fulfill the requirements that are pre-determined, such as minimum volumes. Currently the three biggest harbors make up ~77 % of the total volumes in scenario 1. If Eka were to only focus on the fish farmers that satisfy a certain volume requirement and have a working administration, the transportation would be simplified, the handling would be simplified and the market expectation and predictability would be simplified, all leading to lowered costs for Eka and its supply chain.

Another approach is introducing a focus on specific geographical areas as it would increase the simplifications and further lower the costs. This alternative is especially interesting when it comes to investments in storage tanks and will also lead to greater opportunities in placing demands on the end user.

Both customer focus and area focus will be more favorable if the future market triples resuling in a larger volume for specific areas and customers, creating possibilities for a selection more appropriate for Eka. This would require a minimum volume, dependant on factors such as which harbor, storage, etc. that are available. Comparing the fish farming industry to Eka's other customers in Norway, there is a much higher margin for the fish farming customers but also higher transportation costs. This can be credited to the new market and hidden start up costs that have been a supplemented charge.

What is clear is that if the organization around this industry would become more standardized and the volumes would increase, the transport costs could be reduced. Table 5 shows the freight cost for some fish farming customers and a standard pulp and paper mill (P&P) as well as a very small customer in the hydrogen peroxide special applications (HPSA) section, all within Norway. This shows the benefits from using an area focus with increased volumes in addition to steady flows to the HPSA customers, even though they are quite small. All these transport costs are from the same hauler.

Table 5, Percentage of freight cost using container as primary transport, calculated per ton.

	Fish farms				Non-fish farms	
To	Bergen	Herøy	Ottersøy	Ottersøy	P&P	HPSA
Production site	Rjukan	Rjukan	Rjukan	Alby	Rjukan	Rjukan
Freight cost of tot.	18,3 %	29,9 %	33,8 %	21,3 %	10,8 %	13,1 %

When considering possible focus areas, Eka must also take into account the risks associated with only focusing on specific areas or customers. If the market triples then there are fewer risks associated but they still may remain. There is also a risk of damaging the overall reputation if Eka chooses not to deliver to certain areas, hindering the development there. With a damaged reputation it can be difficult to return to areas or customers previously neglected. In other words, when focusing on, for example, areas the potential market decreases and the risks involved increases.

5.1.4. Potential savings

The potential savings related to the market are hard to predict and extremely dependant on factors outside of Eka's control, and the only way to consider the repercussions is to present different aspects of the effects.

Table 6, Contribution margin ratio using tank trucks as primary transport, calculated per ton.

To	**Bergen**	**Herøy**	**P&P**	**HPSA**	**Ottersøy**	**Ottersøy**
Production site	Rjukan	Rjukan	Rjukan	Rjukan	Alby	Rjukan
Contribution margin ratio	41,0 %	38,4 %	17,9 %	51,2 %	50,1 %	35,1 %

As seen from this table, there are significant differences in the contribution margin ratios to the different customers. The contribution margin ratio is: (Price – Variable Cost) / Price. Variable costs include items such as production, freight and container cost. It should be clearly noted that these figures do not cover overhead costs and other administrative costs and that the margins in this case is only the contribution margin and therefore not the total profit margin.

The contribution margin differs quite heavily, not only between the segments but also among the fish farming industry as well as between production sites. This implicates that there are clearly some areas that are more suitable than others, i.e. more profitable, which increases the positive effects from a focus on certain areas as well as certain customers. The fish farming industries all have high margins, even though they differ quite a lot. Alby - Ottersøy stands out with the highest contribution margin ratio related to the fish farming industry.

These contribution margin ratios show the need for Eka to follow-up all related costs and should provide a basis for future strategic investments, which should be aligned with Eka's overall strategy as well as the future aspects for the fish farming market. It is important to recognize the differences between

areas as well as be aware of all the variables that affect the total outcome. The volume of the specific customers is also an important factor to consider.

5.2. Relationships

5.2.1. Problem description

There is a size difference between the actors within the supply chain which implicates problems with the structural power and balance among them. As seen in the theoretical framework, the structural power and the balance is mostly determined by historical activities between the actors and is difficult to change. Therefore, the unclear responsibilities and too informal structures deepen the complications and the total benefits of the high involvement relationships that currently exist cannot be reaped. With unclear responsibilities there is a risk of damaging the trust among the actors. When the trust does not exist it has to be replaced by control which can be even more hurtful for the entire supply chain.

Lock-in effects exist due to closely linked relationships that would inflict extremely large ex ante costs (2.7.4) that affect not only this market but also other markets where Eka has relationships with the same actors.

The supply chain is, in its current state, structured to be as agile as possible. This results in large costs throughout the supply chain and it is far from certain that this market requires the agility and flexibility of such a supply chain. The need for this was previously motivated but as the market grows and matures, the supply chain must adapt to the new conditions.

When looking at the different flows throughout the supply chain, it is obvious that the flows are not structured and controlled by any actor. Instead all the flows have developed naturally over time. This has lead to a more informal structure as well as a large dependency on trust among the actors for the orders to be processed and handled as desired. Another problem for Eka may be the loss of information related to a more typical supplier role where Eka keeps a distance towards both the end users as well as their customers.

5.2.2. Long term goals

Eka's long term goals are to have close relationships but still keep clearly divided responsibilities. The benefits of having close relationships have been proven successful for Eka, however, the responsibilities should be clearly divided in order for the operations to work more fluently when put to the test.

It is in Eka's interest that the other actors in the supply chain grow so their size related limitations are diminished from a resource and economic perspective. This would increase the possibilities of further developing the supply chain.

Eka may become more of a conventional supplier and take the role of support in HP related questions. This would be more similar to Eka's roles in other supply chains where they are present but should be made with caution and not move away too quickly from the available information. If Eka gains more control over the information part of the supply chain it would lead to a simplified and more efficient structure as well as more control over the supply chain which in turn would lead to better planning.

5.2.3. Proposed changes

The proposed changes are closely interrelated to the problems related both to the market as well as the information structure. The areas are all closely linked and therefore the changes will make a difference, not only within their own area.

In order to solve the problems described, it is important that Eka manages to divide the responsibilities along the supply chain. This can be done through letting the distributor be more responsible for future markets and forecasts and the hauler responsible for the requirements related to the transports. Letting the distributor be responsible for the end users and future strategic areas, etc. can be handled through a larger incentive for them in optimizing the customer basis, for example requiring the distributor to confirm every order well in advance and hold them accountable for any changes.

This will lead to a better structural power and balance since the control is divided along with the responsibilities. Through this set up, there are better chances for a good mix of the stability brought by a large actor, such as Eka, and the flexibility and agility provided by the smaller actors, the hauler and the distributor. This mix would also further improve the power structure and the balance which would not only improve the efficiency of the supply chain but also increase the competence trust in a longer perspective while upholding the goodwill trust as well as the contractual trust (2.7.5).

In order to see differences over time as well as making sure the entire supply chain is on the right track Eka would benefit from evaluating the actors from time to time, to help the actors in the supply chain reach their goals (2.7.6). The evaluation should be done on a predefined basis where the factors of key interest are measured. The ex posts costs (2.7.4) must also be taken into account in order to see how valuable the relationships are, information on the monetary risk is especially of interest to Eka.

The agility and flexibility throughout the supply chain is of great value for the customers. However, this is very costly and there is no need for the level of agility shown so far as the market slowly enters a new phase with more predetermined customers and deliveries. If further demands and restrictions can be put on the actors and thereby the end users, the costs can be reduced further. This is very much up to the distributor to impose, but in order for them to put demands on the end users, Eka must put more pressure on the distributor where necessary, such as in the area of the order handling.

If Eka were to switch transporter due to the hauler being found to be too expensive, extra costs would arise such as lost flexibility and thereby market shares. As seen in the theoretical framework (2.7.2), there are large benefits in high involvement relationships after a certain amount of time. There are also other economic consequences to consider such as ex ante costs, the costs of switching supplier.

There can also be a loss of trust and other benefits if the hauler no longer were required for the fish farming industry, which must be taken into account if evaluating the idea of switching supplier. It is largely due to the hauler that the market has emerged and their knowledge is still very valuable for the supply chain. This makes switching transporter not an option at the moment. However, Eka should see the possibility of using another transporter in areas were the hauler clearly has difficulties such as the route between Alby and Ottersøy. Also, considering scenario 2, the increasing volumes may very well be a problem for the hauler which is not easily handled with them as the sole supplier of transportations.

Therefore, Eka is in that case wise to include other transporters in certain areas to relieve potential problems with the hauler.

5.2.4. Potential savings

The potential savings related to the relationships are the costs linked to the hauler not being able to perform at the optimal level for Eka and the supply chain. Currently this is natural due to the market evolving at a rapid pace but should be considered in the near future, for both the scenarios.

Other potential savings are difficult to develop further since the proposed changes all lay a foundation towards implementing the other proposed changes.

5.3. Information structure

5.3.1. Problem description

There is currently a lack of clear routines between the actors in the supply chain. As described previously in the analysis of the relationships, the lack of routines affects the relationships between them and also affects the efficiency and the ability to understand the changes in the market and among the end users. The problems related to information structure are therefore closely linked to how the relations are structured which in itself is a potential improvement for Eka.

The official orders are placed too late for the supply chain to work efficiently. With late orders comes late information and late decisions which increases the need for flexibility and therefore the related costs. With less supervision and control of the information, Eka is therefore dependant on the trust towards the other actors without many possibilities of making the order handling easier throughout the supply chain.

This also results in much risk for Eka. The transport aspects are necessary to take into account since Eka often have no time to react or to modify regarding where the product is located or its final destination. Another aspect is the apparent risk of Eka being left with large costs, such as containers in the short term, when there are changes in the market that otherwise would have been spotted earlier if there was a more structured information flow.

Another large risk for the supply chain is the dependency on a few individuals located at the different actors. These individuals possess great knowledge and valuable understanding as well as many important connections within the industry. If this is lost the entire supply chain is affected and at worst, diminished. The supply chain is therefore too fragile to be able to further invest and commit to the industry.

5.3.2. Long term goals

It is in Eka's interest to structure the order handling flows in a clear and more logical way. This applies both to product and to transport orders throughout the supply chain. With a separated order handling of product and of transportation, the true demands can be more easily monitored.

An order done through the correct channels and in time, not only saves money with regards to a more efficient use of resources and time, but also eases the possibilities for different follow-ups needed to

simplify the communication and activities. This is however not usual for Eka since the orders are not always done properly and on time even in stable markets. A big difference is, however, that those markets have a more easily monitored output and demand along with a more standardized supply chain.

5.3.3. Proposed changes

In order to best handle the information structure it is important to realize the full potential of the supply chain. If the supply chain would work more efficiently the order flow of the product and of the transport would be separated. This would create a more structured approach which is needed for an uncomplicated handling system without too much administration.

The physical flow as well as the monetary flow should not be changed since they are simple and direct,;this also can be said about the ownership of the product. However, the information flow as well as the order handling can be improved substantially. Most importantly it might be the mindset that needs to change about how orders are traditionally handled at Eka. An alternative to the current order handling is visually described in Figure 20.

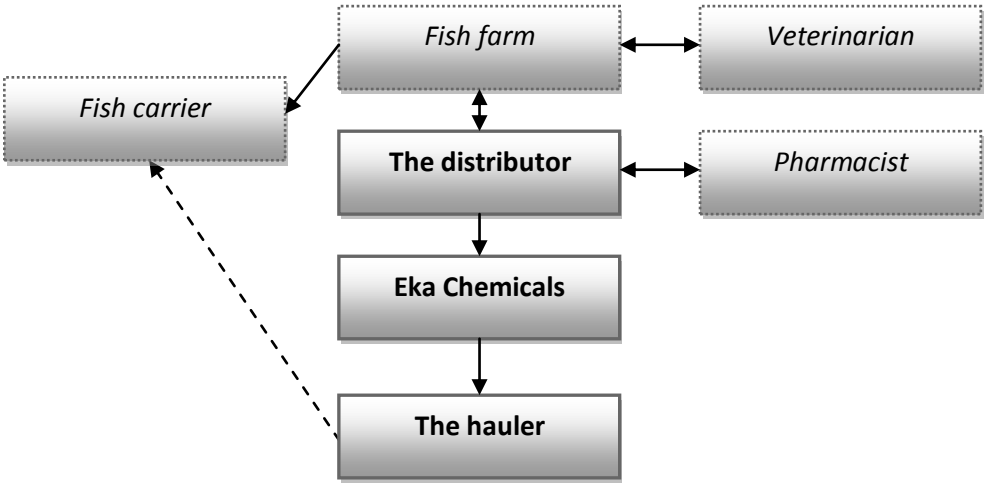


Figure 20, Suggested ordering flow.

Eka cannot make any changes in the initial order handling so therefore it is assumed to be the same as described in the empirical references (Figure 14). Instead, when the distributor receives orders and information regarding the outlook of the market they make a preliminary order to Eka, which should take place two weeks to one month prior to delivery. These orders should contain the amount needed as well as be specified to what region it should be delivered and when. The order is confirmed by the distributor as early as possible with a minimum requirement of days prior to delivery date, for example three working days or what is most suitable for every actor. This provides Eka with the information needed in order to plan the deliveries as well as the production output.

The hauler gets the order, both the preliminary as well as the confirmed order through the SAP system. Since they receive information regarding both time and place they can take advantage of economies of scale along with deliveries to other customers. For example, the deliveries from Alby to Ottersøy could be planned better and therefore increased which would be less costly than shipping from Rjukan.

It will be important that the hauler confirms the delivery, both prior to delivery as well as after. This is done in order to better control the output flow of the product sold and how the product was allocated. It will provide all the actors with better information regarding both the customer needs and also the efficiency of the supply chain. Through this, the distributor will also receive confirmations regarding that the product has been delivered according to the agreements.

The order handling should not be compared to the information flow and be as simple and straightforward as possible to minimize the administrative costs and unnecessary activities. Information will still be exchanged freely among the actors, to keep everyone updated on how the market is changing as well as keep a certain degree of flexibility. This is to ensure the trust is kept and that all information is visible to every participant.

In order to better take advantage of the separated order handling it is crucial to perform follow-ups. This should measure certain key points and the service level specific to the needs and desires from the actors along the supply chain. As described in the theoretical framework (2.2.), the service level can be defined in different ways and should be treated thereafter. For example, it is easy to monitor the actual demand for every region which can be valuable information when deciding whether to expand to certain areas. Follow-ups are crucial in understanding how the collaboration is performing and without it no improvement areas can be identified. The importance of improving every part of the supply chain will continue to grow as the entire market grows.

Eka has service levels that are centrally controlled in every SLA (Service Level Agreement) which state the agreed upon levels for delivery on time and the required loading on time. The problem here is that every transporter is liable to report this by themselves and no special attention is given to it. With the proposed increased usage of SAP, this would automatically transform into service levels and make the follow-ups more visible.

5.3.4. Potential savings

The potential savings to be made are hard to predict since the changes mostly affect the overall factors such as better planning and a more feasible market control. However, possible potential savings may arise especially in the administration around the order handling. With less administration there can be significant cost reductions in a longer perspective, especially if this is extended to include other industries outside of the fish farming segment. One must acknowledge, as seen in the theoretical framework (2.7.3), that the economic consequences of relationships are not always as clear as one might expect. It is an apparent risk that the local administration may increase when shifting the order handling which could present difficulties when implementing this alternative.

For example, if the order handling would be improved the planning would be made in advance. Hence, the deliveries that are not a full truck load, outliers, could be minimized and thereby savings would be made through fewer transports.

Table 7, Cost of outliers for freight during 2010.

	No. of outliers	Current freight cost	Volume	Savings

2010	7	€ 28 826	149,5 ton	€ 10 170
Scenario 1	-	-	-	€ 20 999
Scenario 2	-	-	-	€ 62 997

Table 7 shows the potential savings if the outliers where minimized and instead driven in full truck loads with tank trucks. As seen, the savings are almost one third of the freight cost for these transports. The potential savings for scenario 1 are more than twice the amount in 2010 due to the estimated doubling of the market. However, if the pressure increases on the supply chain during 2011 there is an apparent risk of requiring more outliers leading to further potential savings. The opposite can also be true as a more efficient supply chain will lower the number of outliers. The savings presented for scenario 1 and 2 are assuming the same percentage of outliers as in 2010.

In the shorter perspective there are no direct cost reductions that are feasible within the information structure. Instead, this will help other savings to take place, described in the other sections. For example, the transportation can more easily be planned and therefore the costs can be lowered, both in terms of better planning and the possibility of using economies of scale and also through a better possibility of following the theoretically calculated allocation.

The risk of the existing information structure is that it might break down when the volumes increase. Therefore this alternative can be seen as an investment in order to ensure savings further on. A more efficient supply chain can also lead to an improved reputation for the supply chain which can provide a natural growth within the existing market and thereby lower costs through economies of scale. A well working information structure may be a requirement for the future market.

5.4. Seasonal variation

5.4.1. Problem description

The distributor is Eka's only customer which has a demand with seasonal variation. The size of Eka's other customers range from small to very large, but are usually quite stable in demand, creating an unfamiliar procedure for Eka in this case. It causes problems with the storage only being used for a short time of the year, adding additional costs when bringing containers back to the production sites and limiting the usage of tank trucks. It gives no incentives for the hauler to dedicate equipment and vehicles to the fish farming industry as there are no guaranteed volumes for each month.

Irregular flows will also increase the need for maximum storage at the customer, currently in the form of containers, which is an expensive type of storage. Eka has a production process that is highly dependent on it running at a stable and continuous level and it will add complexity to the planning if the seasonal variation continues growing. As this is a unique situation for Eka, it will be treated as a separate issue compared to increasing volumes and different changes will be proposed.

5.4.2. Long term goals

In an ideal world, Eka would have even output from its production sites over the course of the year, delivering full truck loads straight to customers without the need for inventory, but this is rarely the

case. In reality, it is desirable to even it out as much as possible, with the use of storage, to make the transportation able to have steady flows, lowering transportation costs.

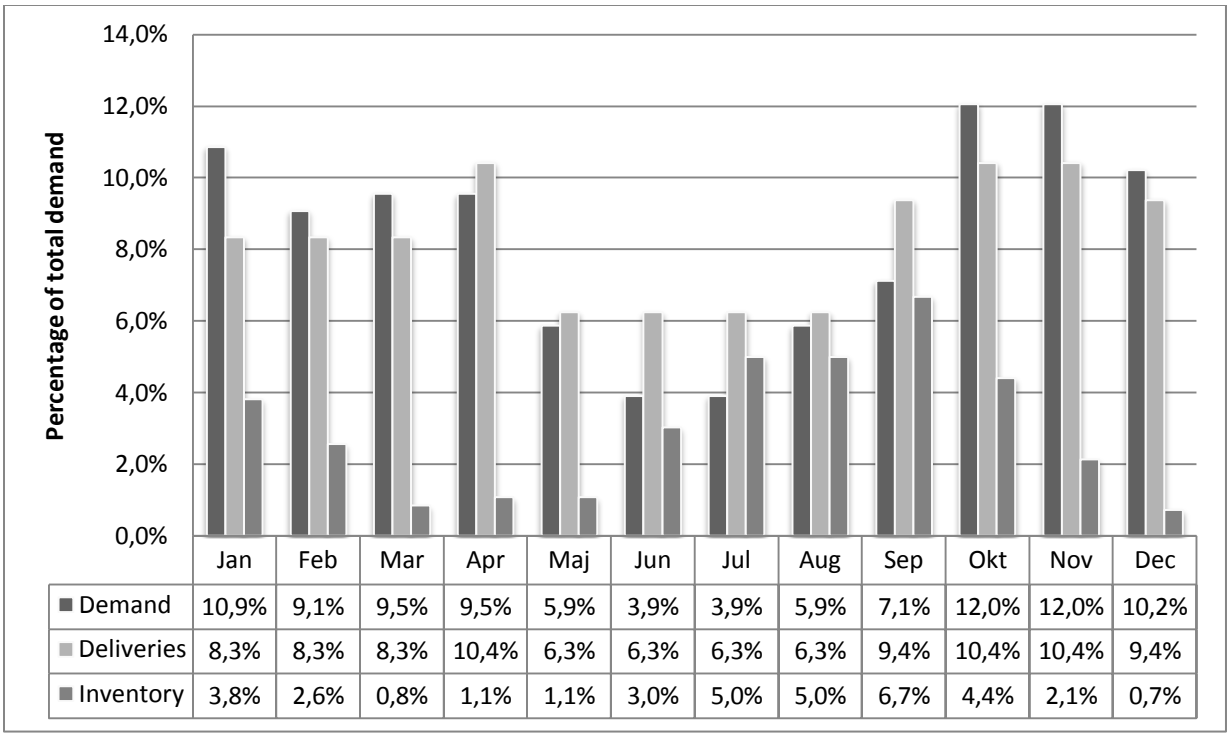
To achieve this, Eka wants to work with everyone involved in the supply chain to reduce the peaks in the seasonal demand, even if the actual usage of the product will still be centered on some specific months. This is primarily due to the governmental regulations that are in place and unlikely to change. Eka can use strategies as well to lower the peaks, for example by implementing a price differentiation strategy.

5.4.3. Proposed changes

Standard ways of fighting seasonal variation (2.4.) are either to use chase or leveled production plan where chase is not relevant in this case as the output is already at a constant maximum (4.3.1). A leveled production schedule could be used in the sense that an inventory is built during the months of no sales. If the inventory is at the production sites, the transportation would still experience seasonal variation and become a constraint. As discussed in 2.5. concerning centralized or de-centralized warehouses, the product in question is not being consolidated at any point or divided for different customers. Because of this and the high costs of additional transport, it is more suitable for direct deliveries to de-centralized warehouses which act as the final destination for land transport.

The de-centralized warehouses would need to be in connection to a harbor which is used on a regular basis to increase the utilization. On the other hand, if storage is to be built along the coast of Norway, several depots would be needed; either formed by ISO-containers or fixed storage tanks. These depots would in turn act as the hub in a split point system where the boats act as last mile transport vehicles. At the volumes of scenario 1, a depot consisting of containers is preferred as it provides flexibility and the volumes just are not there yet.

If the volume would triple, as scenario two suggests, it would suddenly become unworkable with containers, as the administration to keep track of them and have them shipped back and forth for maintenance outweighs the investment cost of a storage tank. For the sake of argument, say volumes increase as in scenario 2 and everything should be stored in containers. Taking the fastest growing harbors Fosnavåg and Bergen and the largest harbor Ottersøy, they would each require 4-5000 tons of solution per year. With the current seasonal variation, that means these harbors will peak at 1000 tons per month, amounting to 30 tank trucks delivered in a month. If it is assumed that the demand is linear over the month that means 250 tons are needed each week or 8 tank trucks. Turning this into a case of estimated storage tank costs and a simulated smoothed demand will look as follows:



	Jan	Feb	Mar	Apr	Maj	Jun	Jul	Aug	Sep	Okt	Nov	Dec
Demand	10,9%	9,1%	9,5%	9,5%	5,9%	3,9%	3,9%	5,9%	7,1%	12,0%	12,0%	10,2%
Deliveries	8,3%	8,3%	8,3%	10,4%	6,3%	6,3%	6,3%	6,3%	9,4%	10,4%	10,4%	9,4%
Inventory	3,8%	2,6%	0,8%	1,1%	1,1%	3,0%	5,0%	5,0%	6,7%	4,4%	2,1%	0,7%

Figure 21, Modified demand and leveled transports.

The size of the storage tank is based on the maximum inventory needed, in this case a 300 m^3 tank. A further aspect in this is that some of the demand is shifted towards the summer, for two reasons; the first being the utilization of fish carriers is evened out and the second being that Eka could offer a discounted price on hydrogen peroxide during the summer months. Details of this are found in Appendix A but summarized it is shown that the investment could be profitable when considering the savings from reduced container usage and if there was a negotiated price drop by The hauler of a minimum of 15%. Anything above this would be pure profit from Eka's side and should be possible due to the current high prices for freight to fish farmers. This is based on the fact that the hauler would gain from this by having a fixed tank to deliver to and primarily that they would be guaranteed a quite substantial minimum volume each week.

The above scenario assumes that the demand could be influenced, but that is something that is not unreasonable as even during 2011 there is a tendency of it being smoothed out as some farms have already planned to do treatments in May. A discount in price, as described in section 2.4, was calculated for the months where treatment is generally not done, providing incentives for the fish farmers to schedule them off-season. It may also be possible that it will be more viable in the future of different areas doing treatments together, starting in the south for example in March and southwest in April and so on.

5.4.4. Potential savings:

Estimating the potential savings of lowered seasonal variation is unreasonable and requires quite a few estimations to be made. The proposed storage tank of 300 m^2 will bring many benefits to the supply

chain and allows for most stable flows of goods to this location. It will be incentivized by a reduction in containers and transport savings primarily, specified in Table 8. The summary from the investment calculations are in Appendix B. This shows an IRR of 14,2 %, which Eka deems enough and a payback period of 5,3 years that can seem a bit long for a 10 year investment.

Table 8, Flattened demand and storage tank with increased volumes.

Changes	
Investment	€ 566 000
Price differentiation cost (5 %)	€ 25 478
Container savings	€ 47 450
Transport savings (15 %)	€ 102 288
Decreased tied-up capital	€ 3397
Internal rate of return	14,2 %
Payback period	**5,3 years**

As this is based on a transport saving of only 15%, there is still much to gain in this department as transport costs would still be considered high. The lowered transport costs can be motivated by guaranteeing a minimum volume, smoother delivery to a fixed tank in a fixed location and economies of scale from scenario 2 volumes.

5.5. Increasing volumes

5.5.1. Problem description

Determining the demand one or two years in advance is very hard in this uncertain market. The reasons for this have been discussed previously and the effect it has is primarily that investments will be hard to justify in the short time frames without taking excessive risks. This section on increasing volumes will instead focus on where limitations will arise if the demand keeps growing at this pace. As this is a HPSA area for Eka which is showing promise the increasing volumes will be looked at favorably as long as the product can be delivered with the same service level and quality. If Eka would simply start selling hydrogen peroxide to every fish farmer without bothering to test the boats, the quality would soon drop and Eka's and the distributor's reputation with it.

Going back to the limitations of increasing the volumes, the first one is the availability of the fish carriers where the treatment is performed. There is not an unlimited supply of these and they are expensive to use, although more are being built and some are being put into circulation this spring. If this limitation was circumvented the transportation of HP would become the next bottleneck in the supply chain. As this is a more then usually complex supply chain for Eka, it has some problems now that would become more obvious as volumes increase if the key people in the chain are not able to cope with the amount of information anymore.

The output from Eka's production sites has been a problem at times, but as the market grows so will the confidence in it from Eka's side and it will become more of a priority. It does not fall within the scope of this thesis to decide what markets Eka should focus on and which ones are most promising, as discussed in 4.4.3. A final limitation which can arise is the relatively small size of Eka's partners, the hauler and the distributor, who both would need to grow in order to satisfy the market demand.

5.5.2. Long term goals

This is closely linked to the long term goals in the market section, with it reaching a stable level while still being enough to make this profitable for everyone involved. Eka wants it at reasonable levels which they can handle and perform well with realistic service levels that rely on either storage close to the customer or increased transport possibilities. They do not wish to be the sole supplier of HP in Norway, just as was pointed out in the market section of the analysis. For this supply chain to succeed there must be a more detailed information structure and formal communication. As this is an expanding customer segment, the opposite to most of Eka's other customers, there is potential to grow and this is something Eka wants to explore further.

5.5.3. Proposed changes

The changes in this section will mainly focus on removing or reducing the limitations and the risks that a growing market brings. From Eka's side it is hard to influence the production of fish carriers except with respect to providing a stable and safe treatment in the boats, raising the profile of this treatment. Eka should continue their testing of ships before they perform live runs and by doing so, ensure the quality of the treatment. It may also be advantageous to ensure that an area needs a minimum level of product before starting up there, to ensure that the desired service level can be reached within reasonable time frames.

One thing they are working on to reduce this limitation of the fish carriers is to perform the treatment directly in the fish enclosures, reducing the need for the expensive fish carriers. This would also require more hydrogen peroxide per ton of salmon but would still be outweighed by the reduced cost from not needing fish carriers. The transportation limitation can be addressed by two different approaches, one referring to the solutions of seasonal variation. This would mean there are even flows of transportation and no high peaks in the demand.

Another solution is to give the hauler longer notice of when a transport needs to be performed so they can plan for it and utilize their vehicles better. As there currently is a tendency within the supply chain to be reactive instead of pro-active, a behavioral change needs to happen concerning late orders and lack of planning. Hopefully this is something that can be addressed from the perspective of information structure and that everyone will realize this must be done to have a functioning organization for when the volumes increase. If the increased volumes can enable the hauler to increase the use of tank trucks for most distances, the freight costs can be reduced substantially.

Table 9, Modified average weights for transportation and savings for 2010. All numbers in tons unless otherwise specified.

	Allocation			Savings		
Production site	Alby	Bohus	Rjukan	2010	Scenario 1	Scenario 2
Current average weight:	29	28,4	27,9	-	-	-
New average weight 1:	32	29	32	**€ 63 344**	**€ 124 998**	**€ 374 993**
New average weight 2:	33	30	33	**€ 78 530**	**€ 154 965**	**€ 464 984**

Table 9 shows the potential savings from using tank trucks over containers during transportation, primarily due to the prices being based on trips rather than volume. This is based on the data received concerning 2010 and during that time period 78% of the transports were done with containers. Some of the low average weights can be warranted by some testing volumes being sent in the startup phase or results of hasty orders needing quick deliveries. Every container used in transportation will reduce the average weight but some containers moved back and forth will most likely be necessary to keep some flexibility in the supply chain, which is why the average weight 1 does not entirely consist of tank trucks and still has 20% of containers in the transportation.

Increased volumes will also likely place Eka in a favorable negotiation position towards the hauler as both will gain from having steadier flows. An increased average weight is not only a gain in monetary terms but also reduces the external effects that will be discussed later on in this chapter.

As Eka wants to reduce the risk they take in all aspects of the supply chain, the unknown growth of the market does not ease this in any way. Using the pre-determined scenario of a large increase in volume, several positive effects will follow, the primary being that the hauler can be ensured of having stable flows, providing better utilized transportation. Another effect is that the distributor and hauler can grow together with the market, as discussed in the relationship section of the analysis, which reduces the risks for Eka and this is what has happened with the Swedish haulers they use for the bulk of their transportation. They started out as small family haulers with a few trucks and have now grown so that they can provide Eka with the necessary transportation.

5.5.4. Potential savings:

The benefits are that increased volumes provide economies of scale for Eka and give them a better negotiation position towards the transporter with benefits for both parties. A more intangible product of this is that the service level will increase with steadier flows and having the product located closer to the customer. The one saving that is obvious and dependent on fixed cost per delivery is that if average weights would increase, costs can be reduced significantly (Table 9).

The negative aspects of keeping storage close to the customer is the investment cost of this and that the product is quite spacious, demanding certain volumes and requirements on storage.

5.6. Transportation modes

5.6.1. Problem description

As mentioned in previous sections, it is favorable to limit the use of containers for several reasons; the long lead time to obtain more containers, the administration to keep track of them and the cost most of all. Eka leases the containers and passes on some of the cost for them to their customers but the positive effects of lowering the number of containers in general still outweigh the negative. Especially as the problem is the growing dependence on containers and it will only increase as the market grows.

A basic concept in transportation is that '*the larger the carrier, the lower the cost per unit*' and this is just as true in the case of bulk transportation. It does, however, bring additional costs in the form of tied up capital and perhaps more importantly, in moving more product from Eka's internal storage to remote locations in Norway, ending up with less safety stock for remaining customers. Focusing on the transportation and its alternatives, Figure 22 shows the benefits summarized from different transport modes. This figure demonstrates that air for example is useful for small volumes of high value goods that are time sensitive and where cost is less of an issue. Sea is in many cases the opposite and should be used for large volumes of bulk material that can be transported with long lead times.

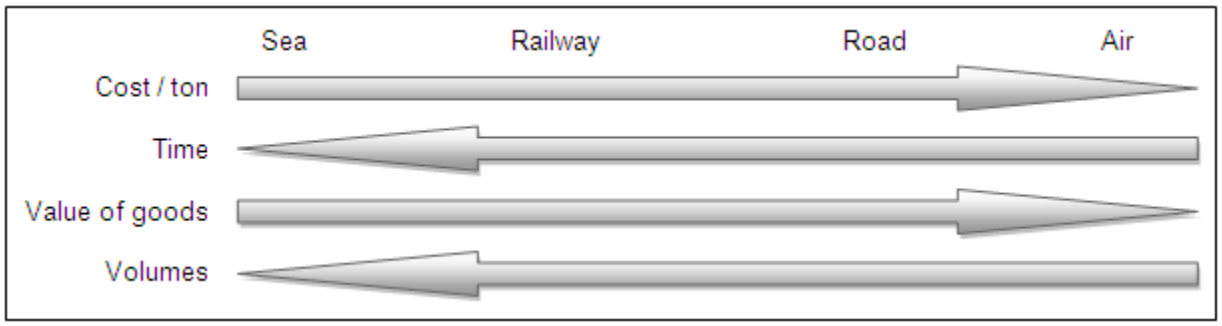


Figure 22, Transportation benefits per mode.

One can quite easily eliminate both sea and air as the volumes are not large enough to justify a sea transport and the volumes are too large for air to be a candidate. This requires no complex calculations but rather common sense to realize that only the Bohus production site would be adaptable to sea freight but this is the least optimal production site for Eka at the moment, when considering the bigger picture. For airfreight the reasons are also obvious - it brings additional limitations on concentrations during transport and this together with the fact that it is a bulk product, makes air a poor choice.

Road transportation is the only option used currently, both with containers and tank trucks, providing the problems already mentioned in the increased volumes section. A railway solution could improve several aspects of the supply chain even if it might increase the lead time and the handling costs. A direct train route and combinations of rail/road will be considered in the proposed changes. A positive effect that makes it interesting to Eka and the main reason for them to want to explore this further is the reduced environmental effects from railway. Train has been successfully used in prior situations in Norway for Eka, but they have no rail transportation in Norway currently and railway is dependent on a very limited infrastructure. Problems will also occur depending on what type of railway transport is

chosen. If it is containers on railway, more containers would be needed due to longer lead times and if it is tank wagon, there needs to be locations for re-loading the HP to trucks for the last part of the journey.

As hydrogen peroxide is classified as dangerous goods (classification 5.1) there are certain limitations with respect to transport and handling. Every driver needs a standard ADR-license and in addition they need to have basic instructions from Eka in order to do the fill ups and drop offs of the product. It can also cause problems when they are meeting the fish carriers in certain harbors, as these can be heavily frequented by pedestrians and other cargo. Another aspect is the re-loading during railway transport that can pose problems in the goods station.

5.6.2. Long term goals

Eka wants a transportation solution which is environmentally sustainable, cost efficient and provides the necessary service level to its customers. It should be adaptable to a growing market and the risk of increased freight costs. The structure around the chosen transport mode should also be changeable depending on volume when it comes to storage facilities.

The final strategy should not only consider current volumes for the fish farmers, but also be adaptable to growing synergy effects from other Norwegian customers, perhaps making a previously discarded option viable.

5.6.3. Proposed changes

The choice between tank truck and container has been shown to be very important due to the freight costs being based on trips rather than a price per ton and the extra cost that a container brings (5.5.). If the transport containers are reduced, more could be used for storage if no tanks are implemented or it can be seen as a reduced cost for Eka. With the market growing, so will the number of containers and it can reach unreasonable levels in a few years. Another option is to get a proper control system for them so that Eka can track them and use them more strategically.

Implementing a railway option comes with some restrictions, first and foremost is the infrastructure and state of the current railway. The most likely choice, in the example of Alby - Ottersøy, for delivering by railway is to transport it by train from the production site in Alby to the train station in Trondheim. However, this route is currently not in use, instead, the possible route is from Alby, down south to Kristineberg, close to Karlstad, Sweden, and then up into Norway to Trondheim.

From there truck must be used for the last ~213 km of the journey. This is obviously not a straight trip and adds much extra distance but is the only possible option currently. In order for the shorter route to be an option, the volumes in scenario 2 must be realized. Since the handling and reloading of dangerous goods requires permits in Norway, the reasonable alternative is to use containers instead of tank wagons. (Westring, 2011)

As seen in Table 10, the total costs of shipping via railway and sending via truck from Trondheim-Ottersøy is larger than sending it by both container and tanker truck directly from Alby. The rail alternative is calculated through estimation that Trondheim-Ottersøy has the same cost/km as the container and tanker truck option. For train to even be considered, a stable flow with large enough

volumes must be established, which is only applicable in scenario 2. Even then, the rail is only an option if the shorter route, Alby-Trondheim, is possible and thereby lowering the freight cost for the rail option.

Table 10, Freight cost/ton Alby – Ottersøy.

Alby - Ottersøy	Container	Tank truck	Railway
Cost € / ton	108	92	112
Freight costs scenario 2	**€ 552 603**	**€ 468 875**	**€ 571 620**

As Eka has more than the fish farming customers in this region, synergy effects can most likely be established with other customers and make rail a more viable option and through using a split point system (2.6.) there can be economies of scale in transporting large amounts of HP to a selected hub somewhere in Norway.

Another situation where rail is the best alternative is for supply to the most northern parts of Norway where there might be potential customers. This might lead to possibilities of using the heavily frequented iron ore rail line between Kiruna and Narvik in Norway. But this is still several years into the future and not something considered in this thesis. The risks of a more complex chain need to be considered as well as the increased lead times that brings tied up capital and loss of flexibility.

The dangerous goods part of the transport is something Eka is used to and so are their haulers, from having ADR-licensed drivers to using the approved routes properly. The only limitation it brings is that Eka needs to approve the drivers personally in filling up the trucks on Eka's sites, due to safety regulations for everyone involved. The re-loading has not been a problem for the transport when using trucks but if a train option is to be considered, the availability of an authorized re-loading location for tank wagons need to be conveniently located.

5.6.4. Potential savings:

The potential savings regarding transportation mode is primarily when using tanker trucks instead of containers. There will be a lowered total freight costs described in sections 5.5. & 5.6. as well as environmental effects described in section 5.8.

Railway is unfortunately not an alternative at this point. It will only become an option if the route Alby-Trondheim is up and running which is only plausible in scenario 2 but far from certain. The total cost for this alternative can be assumed to be lower than the rail alternative of shipping via Kristineberg even though using a diesel driven engine is not as good as an electrified.

5.7. Allocation

5.7.1. Problem description

With the Nordic production of hydrogen peroxide spread over three locations, the allocation of product from the right source to the right customer is essential for Eka to minimize freight costs. This is calculated with the tool WhatsBest and planned production stops for maintenance are considered. The

problems arise when haulers are given too much leeway in deciding where to get the product, sub-optimizing in specific situations. Haulers have been given a lot of responsibility of the supply chain and being in control of the storage tanks and the levels the customer needs to stay up and running until the next delivery. Eka saves money from not having to be involved in this but for the HP to the fish farming industry, this has started to become too costly due to the high freight costs involved.

It is easy for a hauler to argue that they have a truck close by at site A and ready to go when Eka in reality would want them to get product from site B. In this specific situation, it is more beneficial for Eka to agree to it and pay the increased freight cost. What is not properly considered is why the hauler did not follow the guidelines for sourcing in the first place and how Eka can try to influence this without showing distrust towards a hauler that is performing well in all other areas.

There are several contributing factors behind the reasons for not wanting to be locked in to any specific routes. One is that Eka can gain new large customers in north Sweden that change their desired allocation. Another is that the volumes can be reduced overall and depending on where the optimal allocation is at the moment, different sites may reduce their production.

5.7.2. Long term goals

Eka does not only desire to use the production site which is the most cost efficient based solely on freight costs but also takes into account all of their customers to find a theoretically optimal solution. The optimal solution changes on a monthly basis as customers come and go to some extent. This creates a need for Eka to have a flexible system that is not locked into fixed flows over an extended period of time.

5.7.3. Proposed changes

The changes for allocation are closely connected to the ones for relations and information structure, concerning the amount of responsibility given to the haulers and a more formal information structure limiting the hauler's choice. If a formal request for transport would go through the proper channels and end up at the haulers, no choice of allocation would be possible, keeping not only the control at Eka but also an increased cost due to the administration required. Eka has a desire to keep close relationships with their haulers which is favorable in most situations and this would need to be considered in deciding who controls the allocation.

Running WhatsBest has shown that a large part of the deliveries during 2010 were actually sourced from the "wrong" location based on freight cost and the overview perspective. This is due to the immature business of delivering to the fish farms and a very active hauler having a lot of influence, which has been a key factor for this market to grow. Another important factor of this is that WhatsBest is used as an advising tool within Eka and very little follow up is done to ensure that proper allocation is being done.

For this market to be successful a flexibility and especially speed towards the customer was needed to satisfy unplanned demand and therefore some of the allocation can be due to taking the first available transport. The results show a minimum of four trips in September using the non-optimal allocation, confirmed by WhatsBest and the general outline towards the hauler to use Alby for deliveries north of Frøya.

The allocation for 2010 is presented in three cases (Table 11), one being the one actually used, another one for the optimal solution concerning freight cost and finally one using the original setup but allocating 80 % of the transports to Ottersøy from Alby. The savings quite clearly show that due to the volume advantage of Ottersøy it provides the largest entry in terms of savings. Notable is that 100% correct allocation is unlikely to be realistic as there are planned production maintenance stops that will affect this as well as the arrival of new containers for example, that will be filled up in Bohus before being delivered. This will show as a non-optimal solution overall but in reality it will be the most efficient use of resources in a given situation.

Table 11, Allocation for 2010 volumes and potential savings with the same average weights. Note: freight costs are the same for Alby and Rjukan to Herøy.

	Allocation 2010			**Optimal for freight cost**			**Change in Alby - Ottersøy**		
	Alby	Bohus	Rjukan	Alby	Bohus	Rjukan	Alby	Bohus	Rjukan
Ottersøy	39 %	5 %	56 %	100 %	-	-	80 %	-	20 %
Namsos	100 %	-	-	100 %	-	-	100 %	-	-
Frøya	33 %	26 %	41 %	100 %	-	-	33 %	26 %	41 %
Herøy	30 %	-	70 %	50 %	-	50 %	30 %	-	70 %
Bergen	-	-	100 %	-	-	100 %	-	-	100 %
Savings:	-			**19,3 % / € 108 603**			**13,0 % / € 73 303**		

A solution to the allocation problem can be to engage with another hauler for the transport going from Alby to Norway, that may reduce the cost for this, in terms of freight cost, but the cooperation may be damaged in other parts, which is undesirable. If the volumes turn out to be overwhelming for the hauler, a natural transition for this may happen, in a time when the market has matured and become more standardized regarding transportation.

5.7.4. Potential savings:

Proper allocation gives clear and direct flows within the supply chain in addition to the reduced freight cost, a sum that, for example, amounts to over 35 % of the revenue for Rjukan – Ottersøy. This would need to be solved without receiving the cost of positioning trips from the hauler, as these numbers account for no such costs.

Table 12, Summarized from the above table; savings for 2010 using proper allocation.

	Optimal freight solution	**80 % fixed allocation**
Savings in percentages:	19,3 %	13,0 %
Savings in euro:	€ 108 603	€ 73 303

Table 12 shows the summarized numbers, note that this is for 2010 and the volumes will have doubled

just in the last year, providing a larger benefit now and in the future in monetary values. Eka may have to pay for this by losing some flexibility but hopefully this will not be noticeable in a more mature chain.

5.8. Environmental aspects

5.8.1. Problem description

The problems related to the environmental aspects are not an issue within the general aspects and overall environmental work within AkzoNobel as such. The problems may instead be that the environmental aspects are overlooked in the day-to-day work as when transports are ordered or potential customers are considered. There might also be a problem that the overall costs have gained too much attention in relation to the company strategies which clearly states that sustainability is a focus area.

There are risks during transportation due to dangerous goods and Eka have little or no control over the transport planning and final destinations which presents problems regarding all of the existing and possible external effects. Since AkzoNobel is primarily focusing on cradle-to-gate (from resource extraction to the own company's factory gate) when it comes to the transportations not cradle-to-cradle (2.10.), it will not show the full impact of the transportation and therefore not give the best outcome for the total sustainability work but still a good and clear indication.

As seen in the theoretical framework (2.11.) there are large differences in external effects between the transport modes. It not only leads to difficulties in seeing the full potential in certain transport modes but also in evaluating transporters when there is no basis of evaluation for the environmental aspects. While the hauler has environmental goals such as only using euro 5 engines, they still lack specific climate targets and a systematic monitoring system.

Table 13, Distances and emissions of CO_2 in 2010.

Delivered 2010	**Alby**	**Bohus**	**Rjukan**	**Emissions (kg CO_2)**	**Alby**	**Bohus**	**Rjukan**
Ottersøy	24%	3%	34%	Ottersøy	16,7%	4,4%	49,1%
Namsos	2%	-	-	Namsos	1,4%	-	-
Frøya	3%	1%	2%	Frøya	1,6%	1,5%	1,6%
Herøy	8%	-	18%	Herøy	6,4%	-	14,6%
Bergen	-	-	4%	Bergen	-	-	2,6%

Total	**37%**	**4%**	**59%**	**Total**	**26,2%**	**6,0%**	**67,9%**

These numbers are calculated based on the assumption that every delivery must go empty back to the production site. Based on deliveries made in 2010, the total emissions can then be calculated, where the total amount of CO_2 is shown in Table 13. (NTM, 2008) The deliveries are calculated as percentage of the total amount delivered during 2010. The total amount of CO_2 emissions for transports to the fish farming industry was in 2010 almost 160 tons, much due to the great distances especially from Rjukan to Ottersøy where much of the delivered HP were allocated from.

5.8.2. Long term goals

The environmental long term goals are to be perfectly aligned with Eka's and AkzoNobel's goals for sustainability and environmental effects, that the transport mode chosen is the best from a triple bottom line sustainable aspect, i.e. environmentally, socially as well as economically.

Hence, minimizing the risks taken while still profiting from an uncertain market is therefore included in the overall sustainability related to the fish farming industry.

5.8.3. Proposed changes

There would be several positive effects of giving more attention to the environmental aspects of the transportations. For example, it would be more in line with Eka's overall strategies to be more sustainable and using as much green transportation as possible in addition to encouraging haulers to use non-fossilized fuel to a greater extent.

Eka evaluates the transporters as of now (section 0), although this could serve as a basis for more than it currently does. For example, the environmental effects could be significantly lowered through both a change of transport mode but also through better allocation.

As seen in section 4.1.2, Eka is the owner for the product during the transport and therefore takes the risks associated with the transports in terms of environmental effects (section 0). Hence, a better allocation is also favorable in order to minimize the environmental, and thereby economical, risks.

5.8.4. Potential savings:

The potential savings associated are mostly related to the transport mode as well as the allocation. However other intangible savings exists such as goodwill and the value for Eka to better reach their overall environmental goals and to find the most sustainable solution in terms of the triple bottom line: environmental, economical and societal values.

Table 14, Total CO_2 emissions in 2010 and potential emissions if the allocation to Ottersøy would be optimal.

Emissions (kg)	2010	New allocation
Ottersøy	112 240	68 055
Namsos	2 271	2 271
Frøya	7 547	7 547

Herøy	33 717	33 717
Bergen	4 162	4 162
Total	**159 937**	**115 752**

As seen in Table 14, if the allocation for transports to Ottersøy would solely be taken from Alby instead of Rjukan and Bohus it would mean 44 tons less CO_2 emissions. This reduction means that the total emissions related to the transports to the fish farming industry would be reduced by 27.6 % simply by following a part of the optimal allocation presented in section 5.7.

Table 15, CO_2 emission if rail replaces Alby - Ottersøy with the optimal allocation in scenario 2.

Scenario 2	Distance (km)	Emissions (kg)
Alternative 1		
Road: Alby - Ottersøy	444	**142 255**
Alternative 2		
Rail: Alby - Trondheim	380	8 259
Road: Trondheim - Ottersøy	213	68 244
Total		**76 504**
Reduction		**46,2 %**

As seen in Table 15, the rail alternative consists of rail from Alby to Trondheim and from there by road to Ottersøy. Comparing this alternative to the new allocation option, the difference in CO_2 emissions is 65 tons/year, a reduction of 46,2 %. (NTM, 2008) When regarding scenario 2, the total amount of HP sold in Ottersøy is not tripled as it is when looking at the total amount of HP sold. Instead, there is a limitation calculated that leaves the total amount of HP sold in the region to almost twice the level of scenario 1.

6. Discussion

As can be seen in the analysis, there are many problems related to the HP being sold to the fish farming industry, but also many possibilities. Some of the problems that have been the focus of this report are not anything Eka can affect by themselves. Instead they must rely on the growing market or external decisions that affect the possibilities of a well functioning railway between Alby and Ottersøy for example. The discussion is focused on problems that can be addressed and have been centered on three implementations that will affect the problems discussed previously;

- *Apply a structured order handling for the supply chain with clearer demands.*
- *Implement clearer divided responsibilities within the supply chain in order to follow-up and continuously improve.*
- *Implement an area focus with fixed container depots. Focus more on these chosen areas instead of trying to satisfy the entire market.*

These three changes have large synergy effects and are best viewed as a whole since they all correlate and support each other. Through these changes, the problems will be decreased and the potential benefits and savings mentioned in the analysis can be achieved.

The order handling should be reconsidered as the analysis discussed and through it gain clearer demands and increase the pressure on the actors involved. This may be difficult in some aspects due to the lack of existing planning from the supply chain but that is exactly why it needs to be done.

This will primarily address the problems related to the market as well as the information structure. With a more stable order handling, the market's predictability will be improved as well as the visible information, leading to more accurate decisions as the facts are brought into the light.

When dividing the responsibilities it is important to acknowledge the involved actors without diminishing their opinions. Through a divided responsibility, the actors can focus more on their tasks and gaining control over these. With the newly implemented responsibilities comes the possibility of more standardized follow-ups and evaluations. This will help the entire supply chain to become more efficient as well as increase the trust between the actors.

It is important to maintain solid relationships with both the hauler as well as the distributor, something that these changes will take into consideration. With increased responsibility all actors may improve separately in order to become a well functioning supply chain. It also tackles the problems related to increasing the volumes with more focus and with desire for development, stemming from the divided responsibilities. Furthermore it will help improve the allocation and thereby many of the environmental aspects brought forth in the analysis.

When implementing an area focus it is crucial that it is based on correct facts and the right knowledge. Hence, the distributor with their responsibility towards the market has a key role in providing the correct analysis. These areas should provide a stable base for every actor involved through fixed container depots allowing for easier transportation and handling as well as improved planning.

Through an area focus with container depots, Eka will completely or partially resolve the problems correlated with seasonal variation and also with the market and increasing volumes. It is an important step towards achieving long term perspectives towards the entire fish farming industry and is something that may be crucial if the volumes do not increase heavily within the near future.

6.1. Research Questions

These research questions were stated in section 1.2. and are answered based on the report, especially the empirical framework and also the analysis.

- *How is the current supply chain structured and what advantages/disadvantages does it bring?*

The supply chain and all its actors and components have been thoroughly discussed, primarily in the empirical findings and the analysis. It does lack standardization and it is neither adapted for an increase in volume nor to competing with a substitute product. To the contrary, the supply chain has taken the form of an agile supply chain that is inappropriate for this kind of product. The proposed changes will all help in streamlining the process and making it ready to face future challenges.

- *What modes of transportation are suitable for delivering the hydrogen peroxide to the coastline of Norway?*

Large limitations set by the product and the transport modes themselves have focused the discussion on what kind of trucks rather than which transport mode that is suitable. Infrastructure and geographical difficulties both hinder the advancement of railway transportation in this area. Going back to the truck options and the fact that it is, above all, full truck loads operating these routes, a larger vehicle is for the most part more efficient. This leads to the advocating of tank trucks over containers as the cost of each transport would be lower both by freight cost and reduced container cost.

- *Are there any possible solutions regarding the storing of the product closer to the customer?*

As the market is still growing and it is uncertain when it will stabilize, no investments will be suggested. What should be done however is to use the currently available containers more as fixed depots and store product closer to the customer, encouraging the use of tank trucks. If the volumes increase upwards to scenario 2, it may be favorable to use stationary storage tanks of larger sizes at strategic positions in the harbors that can satisfy it. Proper storage facilities will make transportation easier to plan and carry out, allowing the hauler the option of treating it as any pulp and paper customer.

- *How is the product allocated from the different factories? Is this a factor to improve?*

During 2010, large discrepancies were found for the allocation and proved to be quite costly for the company. This issue will be addressed by separating the product ordering from the transport ordering, keeping the control at Eka. There have been recommendations set forth by Eka but no real follow-up has been done to see why this was not carried out. Improvements should and can be done relatively easily and with low costs.

- *What does the optimal supply chain look like and why is this solution the most suitable?*

It all comes down to what Eka sees as their strategy and future for this segment and how to make this into an even more profitable business. As Eka is used to being a supplier and not much more, this should be the aim for the fish farming segment as well. This will allow them to take fewer risks as they are dealing with smaller actors and an uncertain market. It is now a quite unstructured and reactive supply chain with many solutions on a case-to-case basis, which is something that would need to change as the market grows. To improve a supply chain properly, service levels and points of interest need to be measured in order to find weak spots and see if they are improving when things change. Another area of improvement is to focus its means on a specific area that shows potential and establish that this treatment can be competitive and structured, setting an example not only towards the market, but also internally for Eka, that this is a promising segment.

6.2. Further Research

Further research may be needed depending on how the market alters in the future. If scenario 2 is realized there are several topics that must be looked into. For example there is a risk of the hauler not being able to cope with the large increase in volumes. Hence it would be a good idea to evaluate the alternative of including another transporter on some routes. This will reduce the risks and potentially give more allocation benefits.

If there is an increase in volumes, there is a possibility of investing in a storage tank which would minimize the container costs and advocate the use of tank trucks. Other upsides include increased control over the entire supply chain as well as easier transportation planning.

Also, it might be of interest to reconsider the railway alternative between Alby and Ottersøy when the volumes have increased. Although, for this to be plausible, the existing railway must be upgraded and have a real possibility of steady flows.

Further research needed in order to fully utilize every potential is to consider what synergy effects that can be had, both from the alternative with scenario 2 and also as of now with the traditional customers in the pulp and paper segment. For example, if there are customers requiring the same product, this can lead to economies of scale when it comes to transports as well as in storage.

7. Recommendations

- ***Apply a structured order handling for the supply chain along with clearer demands –*** *To allow for better planning throughout the supply chain and ensure proper handling of hydrogen peroxide.*

    - Preliminary orders are to be registered in the system 2 weeks to 1 month prior to delivery.
    - A confirmed order should be done at least a few days prior to the actual delivery.
    - Information sharing with the hauler will allow them to better utilize their resources and improve the efficiency of the transportation as well as allocation.

- ***Implement clearer divided responsibilities within the supply chain in order to follow-up and continuously improve –*** *So that each operation is controlled by a specific actor and that individual improvements can be made.*

    - Implement a visual tool that measures predefined service levels that are relevant to the area, either for haulers or distributors. Evaluation should be on a co-determined basis integrated in the SLA's and used as an improvement tool.
    - Work together in order to improve and set shared long term goals.
    - Utilize the current SAP system properly and allow for direct access by the distributor and the hauler.

- ***Implement an area focus with fixed container depots. Focus more on these chosen areas instead of trying to satisfy the entire market –*** *In order to build a functioning system that can accommodate the market in targeted areas.*

    - Select two to three areas that are already showing a large enough volume or a potential of this in the coming years.
    - Implement stable flows with standardized routes and storage that can satisfy the market in a less complex manner.
    - When these areas have matured and satisfied Eka's goals, it can be used as a benchmarking solution for the supply chain and towards potential customers.

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9. Appendices

9.1. Appendix A - Calculations for storage tank

- Removed due to secrecy agreement –

9.2. Appendix B - Investments for storage tank

- Removed due to secrecy agreement –